## ACKNOWLEDGMENTS

The author is indebted to Leslie H. Parmele, agricultural engineer, Northeast Watershed Research Center, Agricultural Research Service, U.S. Department of Agriculture, for his contribution to this paper. This manuscript was prepared in cooperation with the Agricultural Experiment Station of The Pennsylvania State University, University Park, Pa.

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## CONTENTS

# A SYSTEM FOR COLLECTION, PREPARATION, TRANSLATION, AND COMPUTER REDUCTION OF DIGITAL HYDROLOGIC DATA

by Jan C. Carr[1]

## INTRODUCTION

A system for collection, preparation, translation, and computer reduction of digital hydrologic data has been developed at the Northeast Watershed Research Center, University Park, Pa. This system represents a significant improvement over the tedious handwork of visually recording data from a pen trace chart.

The use of digital-recording hydrologic gages presents several problems in the development of a data-processing system. (1) Visual inspection of recorded data to detect instrument abnormalities and correction or identification of such malfunction errors is practically impossible. Thus, operators rely on the computer for detection of these errors more so than on analog chart data. (2) The amount of recorded data produced is large, because the readout device operates continuously; however, this volume of records is easily handled by high-speed computers. (3) One advantage of this recorder is minimum human-contributed errors. This is due to not having to transfer and correct data from charts to computer input form manually.

Corrections may be made upon digital data records manually, but these are normally restricted to areas that tapes may have torn or that may have been disfigured by the recorder. In this case, the proper gage reading must still be recognizable. (4) The ability of this recorder to run continuously and unattended for long periods of time is a great advantage, because fewer site visits are necessary, and less time is needed to identify, process, and store the records.

The following sections describe this data-collecting and processing system for digital hydrologic data. Field data collected from the Mahantango Research Watershed located near Klingerstown, Pa., was used to illustrate the operation of the system. A flow diagram of the system is shown in figure 1.

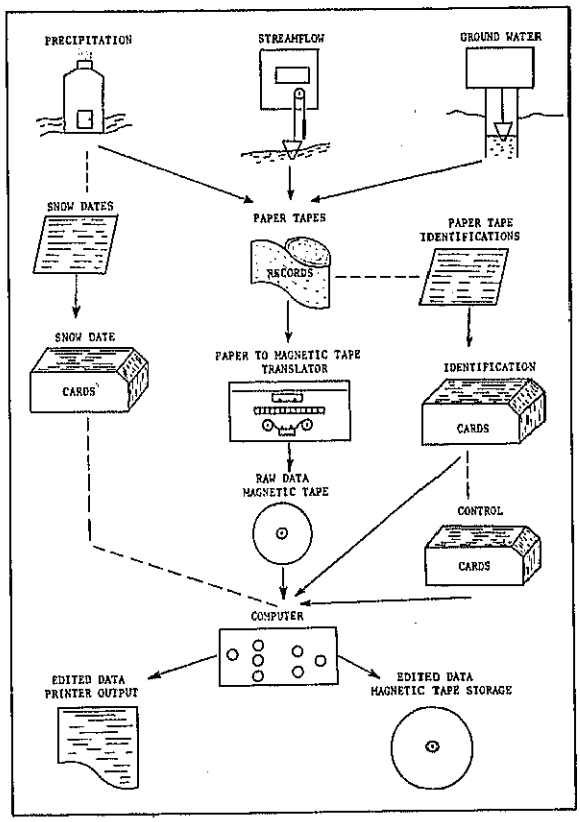


Figure 1.–A flow diagram of the digital hydrologic data-handling system.

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## DIGITAL-RECORDING GAGES

The type of digital recorders used on the Mahantango Watershed network are the Fischer and Porter precipitation gage (fig. 2), water level gage (fig. 3), and tide gage (fig. 4).[2]

The precipitation gage mechanically converts the depth of accumulated precipitation onto a binary-coded, punched paper tape at selected time intervals. This gage has a standard 8-inch orifice, collector capacity of 20.0 inches, and recording accuracy to the nearest 0.1 inch. A rain trace sensor is incorporated within the gage collector to provide a more accurate record of the beginning and ending of precipitation events. This sensor operates normally during summer months. Timing for the collection of precipitation is done by a 5-minute, solid-state electronic timer driven by a d.c. power supply. The 5-minute-interval punch-out provides 105,000 readings per gage during a 1-year period. Of these readings, approximately 500 will suffice to describe precipitation events that occurred during the year.

The water level gage incorporates a float, counter-balance pulley mechanism to transfer streamflow depths onto punched paper tape. This gage operates on

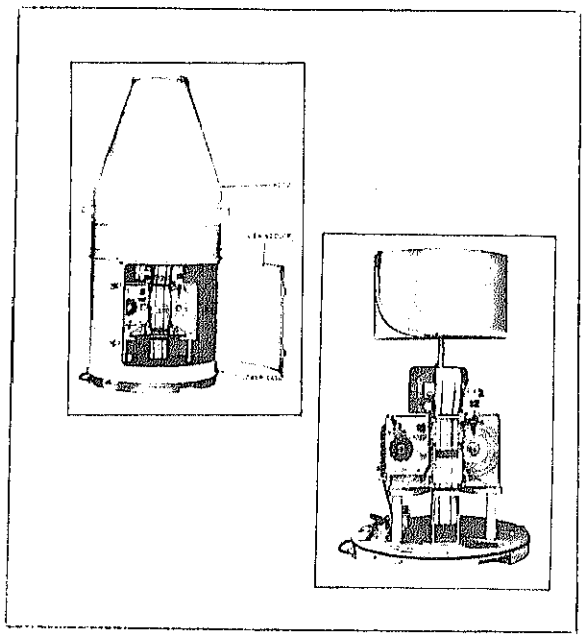


Figure 2.–A digital-recording precipitation gage.

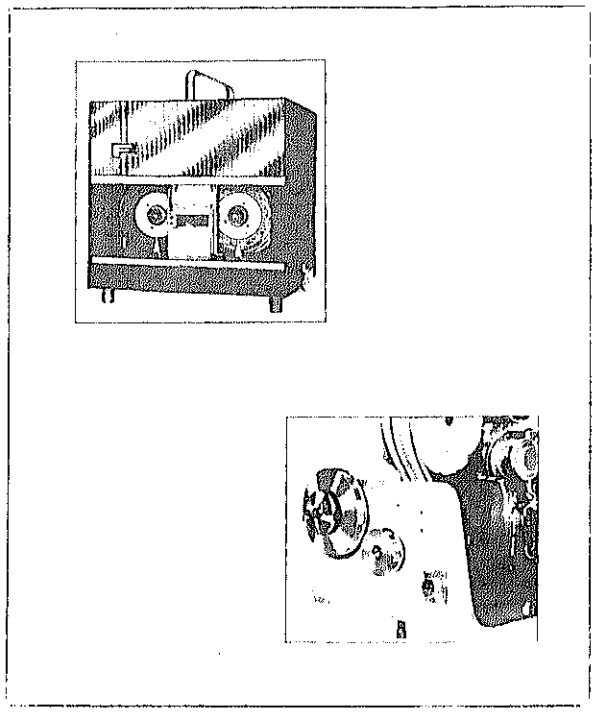


Figure 3.–A digital-recording water level gage (streamflow).

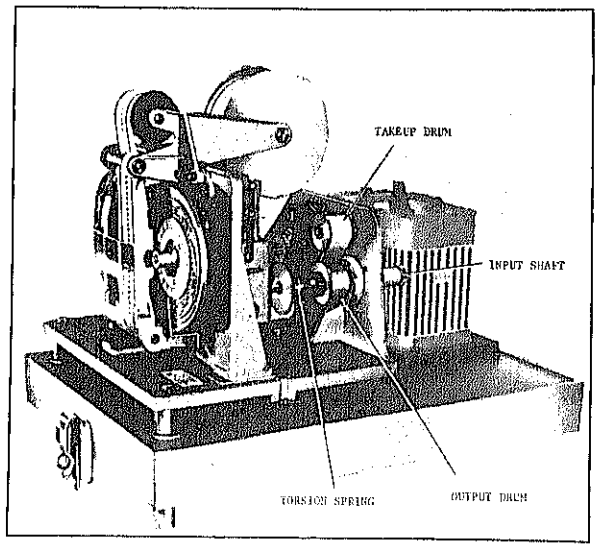



Figure 4.–A digital-recording tide gage (ground water levels).

[2]Fischer and Porter Company, Precipitation gage-recorder, Instr. Bul. 35-1558-1, punched-tape level recorder, Instr. Bul. 35-1541-4, Rev. 3, tide gage, Instr. Bul. 35-1550, Rev. I, 1970.

a 5-minute-interval punchout is the precipitation gage. Approximately 10,000 of the 105,000 readings are needed to depict the fluctuations of stream depths during the year.

The tide gage for recording ground water well levels differs from the water level gage. The gage uses a counterbalance spring in place of a counterweight to facilitate measuring water levels in a well pipe, where sufficient room is not available for a counterweight. Both the tide gage and the water level gage record continuous water levels to the nearest 0.01 foot up to 50.00 and 99.99 feet, respectively. The tide gage operates on a 30-minute-time-interval punchout, with each of the 17,520 readings per year used to describe continuous well levels during the year.

Each gage's punchout mechanism may be operated manually by means of a switch. This manual operation provides a test on punchout alignment and gage time versus clock time synchronization.

## DIGITAL PUNCH PAPER TAPE

The punch paper tapes shown (fig. 5) have a width of 2 1/8 inches, and a length that varies with available time scales. One day's record with a 5-minute time scale requires 28 5/8 inches of tape length, while a 30-minute time scale requires 4 7/8 inches.

The paper tape is divided along its length into crosswise lines which represent the clock time at which punchout occurs (see fig. 5). A 5-minute tape is identified at 10-minute-increments in the center of the tape. Hour lines are marked by heavier lines and are identified in the military time scale. Each day on the tape is consecutively stamped with red numerals. These provide a count of the total tape days elapsed from beginning to end of a record period.

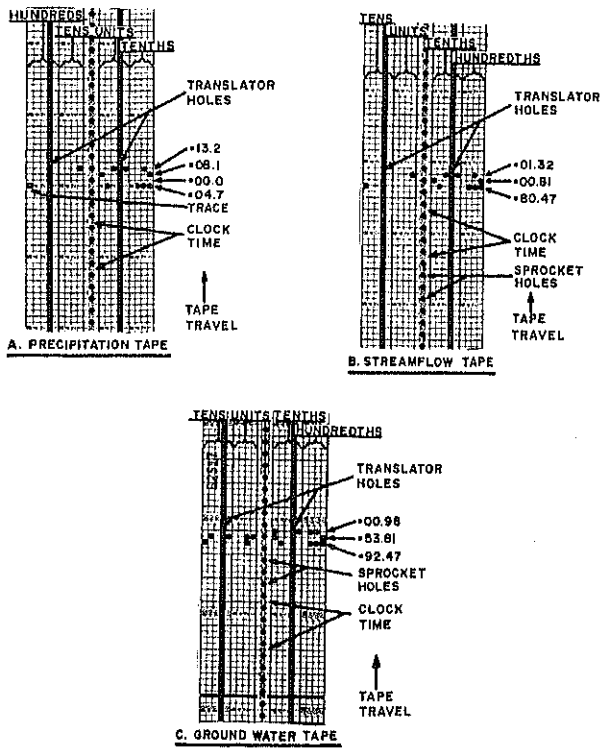



Figure 5.—Digital punch paper tape usage.

The tape is divided into 16 channels, two wide black lines, an area along the tape center that contains the time interval markings, and large sprocket drive holes that are used by the recorder to feed paper tape. The 16 channels are subdivided into four groups of four channels each. In the individual groups, channels are binary coded "1-2-4-8."

Any number can be represented by the appropriate selection of these codes. Those codes not selected are zero. For example, using the tape for precipitation (fig. 5A), a summation of the farthest right-hand group of punched holes establishes the tenths digit. The next group, moving from right to left, gives the units digit, and the third group provides the tens digit. Since the recording accuracy of this gage is to the nearest tenth of an inch, and since capacity is 20 inches, these three groups provide a three-digit precipitation readout, leaving the hundreds digit, or the fourth and final group, unused. Normally, during the summer months when the rain-trace sensor is operative, a trace of rain is noted by a trace punchout in the binary 8 channel of the fourth group.

The punched paper tape (fig. 5B) used in streamflow recording is identical to the tape in figure 5A, except that the four groups provide a different numerical representation. The first group represents the hundredths digit; the second group, the tenths digit; the third group, the units digit; and the fourth group, the tens digit of a four-digit number. The ground water level punch paper tape (fig. 5C) differs from the streamflow tape (fig. 5B) only in its time scale. The two wide black lines shown on each tape are channels for the placement of translator alignment holes, which are automatically punched in the tape during each 5- or 30-minute-punchout to provide proper tape alignment during the paper-tape-to-magnetic-tape translation.

## GAGE LOCATION IDENTIFICATION

A one-half-square-mile grid system was developed for the Mahantango Watershed to identify each gage by a numerical location code (fig. 6). The north to south grid lines represent parallel longitude, while the east to west lines represent parallel latitude. Grid squares were lettered alphabetically A through U from north to south, and numbered 1 to 65 from east to west, respectively. Further subdivision of individual grids can be provided to give more accurate gage locations.

A prefix was used in conjunction with the gage location to indicate the type of instrument as follows:

R - An individual rain gage location.
M - Meteorological sites (rain gage, evaporation, wind, humidity, and temperature station).
G - Open-channel stream-gaging station.
W - Weir-control stream-gaging station.
A - Aquifer (ground water well station).

Example: RG32 is a rain gage recorder station. R designates rain gage, and G32 is the grid square location code of the gage on Line G and Column 32.

A watershed identification number, developed by the Agricultural Research Service, was used to designate the State and watershed location within the State. The State location number assigned to the Mahantango Watershed, Pa., is 16. Each of the six subwatersheds within Mahantango Watershed were numbered 0.01 through 0.06, and the watershed identification numbers, referred to as IWID, are as follows:

| Subwatershed | Stream Gage | IWID |
|---|---|---|
| Mahantango Creek | GRO4 | 16.01 |
| Deep Creek | WO16 | 16.02 |
| Little Mahantango Creek | GK27 | 16.03 |
| Pine Creek | GM27 | 16.04 |
| Run Stella Run | WJ30 | 16.05 |
| Three-Square Mile | WE38 | 16.06 |

The combination of watershed identification and gage location numbers provides sufficient numerical representations of a particular gage within a certain watershed.

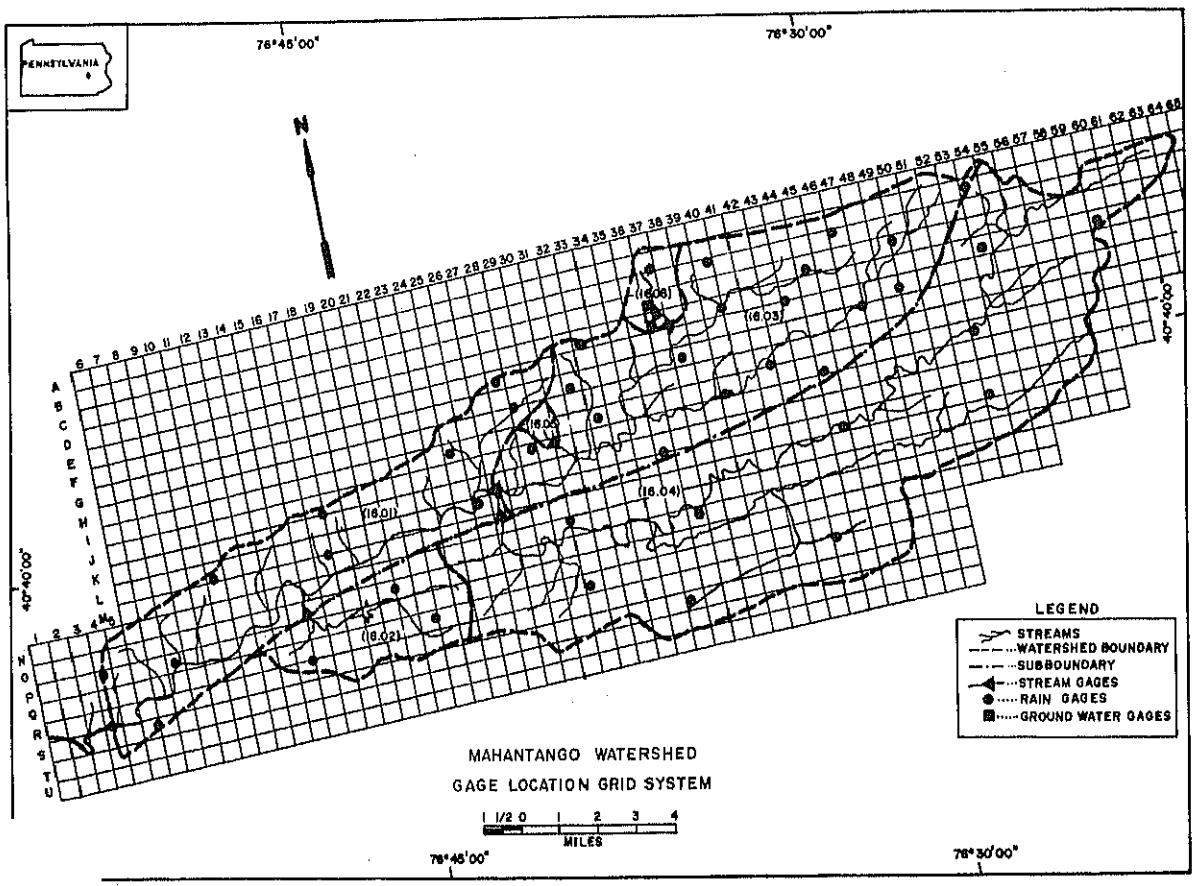



Figure 6.–The gage location grid system.

## PAPER TAPE DATA COLLECTION

The maximum paper tape collection period varies, depending upon the punchout timing cycle. Experience with the Mahantango network has indicated that a monthly collection period is most efficient when those gages are operated on a 5-minute time cycle, and twice a year for those gages on 30-minute cycles. The punched records are stored by the gage on a takeup spool, with the beginning of the collection period located on the inside of the rolled tape.

A 10- to 12-inch length of unpunched tape precedes the punched record. The unpunched area is used to record notes such as gage number, beginning date, time, and punched value. Prior to the start of recording, a series of six or more manually initiated punchouts are placed in the tape in the area beyond the notes. These punchouts supply the feed alignment holes required during the translation procedure. A red felt-tip marker line is drawn across the beginning punchout of the collection period. This line separates the first gage punchout time interval from the preceding manual punchouts and provides a visual notation of the actual beginning of record.

The current paper tape record begins with the time that the previous tape ended, resulting in duplicate punchouts between each collection period. The purpose for following this procedure is to establish a standard method for removal and installation of the paper tape records. The computer reduction step is designed to take into account that duplicate punchout times exist between each tape record.

Two exceptions to this standard method may occur. A complete loss of data, due to gage failure, would require the following tape to begin with the present watch time, and a special notation of the data loss would be made (see Loss Data Cards, "Computer Input Section"). A time loss or gain, either of which can occur with the digital gage, will also require a special notation. In this case, the beginning punchout of the following paper tape will not be identical with the ending punchout of the previous tape, but the new record would begin with the same watch time as the ending watch time of the preceding period. The special notation in the form of a numerical error code, described under the "Paper Tape Data Preparation" Section, would be noted on the tape record which had the punchout time loss or gain.

With the established method of tape removal and installation, the manual punching mechanism is used to synchronize each paper tape collection period to standard watch time. A minimum of 6 inches of unpunched tape must follow each collection period. This length is needed during the translation procedure. A field check list (table 1) is kept of the paper tape records for each gage. The field notes supply a complete gage history.

*TABLE 1.–A field check list depicting information from a precipitation gage recorder*

FIELD CHECK LIST FOR F&P RECORDERS

NEWRC-1
(8/67)

INSTRUMENT NO: M 78
TIMER NO: 11-69-2
LOCATION NO: M-E 37

WATERSHED: Mahantango 1606
LOCATION: Earl Brown

| | | | | | |
|---|---|---|---|---|---|
| DATE TO BE SERVICED | | | | | |
| DATE ACTUALLY SERVICED | 02-08-72 | 03-10-72 | | | |
| **SYNCHRONIZATION** | | | | | |
| Correct E.S.T. | 1420 | 1345 | | | |
| Tape Time | 1420 | 1345 | | | |
| Time Correction | 0 | None | | | |
| Tape Day No. | 21672 | 21704 | | | |
| **TAPE SUPPLY** | | | | | |
| Supply Tape Replaced | 11-02-71 | | | | |
| Tape No. | | | | | |
| Days Remaining on Tape | 404 | 404 | | | |
| Record Removed | 02-08-72① | 03-10-72② | | | |
| Notation on Tape | Yes | Yes | | | |
| **INSTRUMENT READING** | | | | | |
| Dial Reading | 3.7 | 9.7 | | | |
| Tape Reading | 3.7 | 9.7 | | | |
| Punchout in Line | Yes | Yes | | | |
| Punchout Clean | Yes | Yes | | | |
| Sensitivity Checked | Yes | Yes | | | |
| Range Adjusted | 02-16-70 | NO | | | |
| Zero Adjusted | 01-11-72 | 03-10-72 | | | |
| Collector Emptied | 01-11-72 | 03-10-72 | | | |
| Calibration Made | 10-12-71 | 03-10-72 | | | |
| **BATTERY SUPPLY** | | | | | |
| Battery Replaced | 10-12-71 | 03-10-72 | | | |
| Voltage Across Battery | 7.2 | 7.8 | | | |
| Voltage Across Motor | 7.1 | 7.7 | | | |
| ma Drain of Timer | 6 | 4 | | | |
| ma Drain at Punchout | 145 | 135 | | | |
| **OPERATION** | | | | | |
| Evap. Suppression Oil | 01-11-72 | 03-10-72 | | | |
| Dashpot Fluid Added | NO | NO | | | |
| Contacts Cleaned | 02-08-72 | 03-10-72 | | | |
| Material in Collector | NO | NO | | | |
| Mechanical Malfunction | NO | NO | | | |
| **SEASONAL OPERATION** | | | | | |
| Trace (In or Out) | OUT | IN ③ | | | |
| Trace Battery Voltage | | 6.8 | | | |
| Funnel (In or Out) | OUT | IN | | | |
| Antifreeze Installed | 01-11-72 25% | NO | | | |
| **GAGE SERVICED BY** | M.P. | M.P. | | | |

①② (Make Additional Comments on Back)

## PAPER TAPE DATA PREPARATION

A hand-operated roller is used to rewind the paper tape record to place the beginning of the record period on the outside of the roll. The hollow core of the rewound tape must be at least three-fourths of an inch in diameter to meet the requirements of the translator supply spool. During the rewinding of the tape, a visual scan is made for detectable errors. A four-digit, error-coding system was developed for use in identifying any gage malfunctions, such as time loss or gain. Each paper tape record is coded by one of these error codes (App. 1). The rerolled paper tape records are labeled (fig. 7) as to State watershed number (IWID),

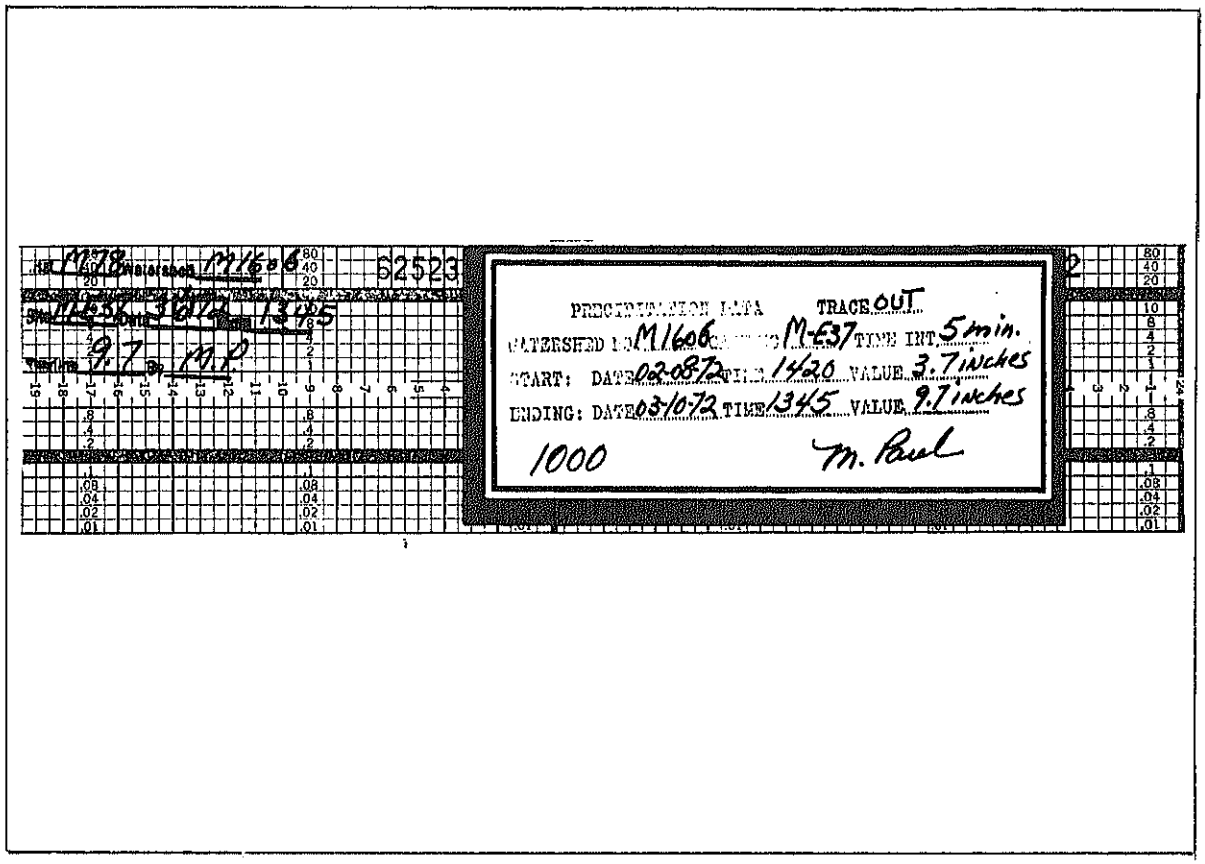



Figure 7.–A paper tape record identification label.

gage location number, trace operation, punchout time interval, beginning and ending date, time, punched value, and error code.

The information from the tape identification labels is transferred to a "paper tape identification form" (table 2). Each horizontal line represents a record

*TABLE 2.–Paper tape identification form (precipitation, streamflow, and ground water)*

PAPERTAPE IDENTIFICATION FORM -- PRECIP, RUNOFF, AQUIFER

NWRDP - 3

STATE: PA. IWID: 16.06 WATERSHED: MAHANTANGO CK. YEAR: 1970

| ERROR CODE | GAGE NAME | PUNCH | TYPE | TRACE | TAPE ON: MO. | DAY | YEAR | HR. | MN. | READ | TAPE OFF: MO. | DAY | YEAR | HR. | MN. | READ | TRANSLATOR CODE: CHEK | LIST | ITCH | DATA | ELE. REF. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1000WE38U | 05 | 2 | | 01 | 01 | 1970 | 12 | 50 | 0023 | 02 | 04 | 1970 | 17 | 00 | 0019 | 1 | | | | |
| 1 | 1020WE38U | 05 | 2 | | 02 | 04 | 1970 | 17 | 00 | 0019 | 03 | 05 | 1970 | 08 | 35 | 0052 | 1 | 1 | | | |
| | TIME LOSS NOT APPARENT REASON AT 02-13-1970 1820 GAGE STOP | | | | | | | | | | | | | | | | | | | | |
| 1000WE38U | | 05 | 2 | | 03 | 05 | 1970 | 08 | 35 | 0052 | 04 | 04 | 1970 | 18 | 25 | 0031 | 1 | | | | |
| 1000WE38U | | 05 | 2 | | 04 | 04 | 1970 | 18 | 25 | 0031 | 05 | 08 | 1970 | 18 | 10 | 0121 | | | | | |
| 1022WE38U | | 05 | 2 | | 05 | 08 | 1970 | 18 | 10 | 0121 | 06 | 18 | 1970 | 13 | 20 | 0083 | 1 | | 1 | | |
| | | | | | | | | | | | 06 | 17 | 1970 | 11 | 20 | 0082 | | | | | |
| ONE DAY AND 2 HOUR TIME LOSS LEAF SWITCH BROKE GAGE STOP | | | | | | | | | | | | | | | | | | | | | |
| 1000WE38U | | 05 | 2 | | 06 | 18 | 1970 | 13 | 20 | 0083 | 07 | 17 | 1970 | 08 | 00 | 0061 | | | | | |
| 1000WE38U | | 05 | 2 | | 07 | 17 | 1970 | 08 | 00 | 0061 | 08 | 21 | 1970 | 09 | 15 | 0020 | | | | | |
| 1000WE38U | | 05 | 2 | | 08 | 21 | 1970 | 09 | 15 | 0020 | 10 | 01 | 1970 | 11 | 15 | 0018 | | | | | |
| 1000WE38U | | 05 | 2 | | 10 | 01 | 1970 | 11 | 15 | 0018 | 11 | 10 | 1970 | 12 | 00 | 0081 | | | | | |
| 1000WE38U | | 05 | 2 | | 11 | 10 | 1970 | 12 | 00 | 0081 | 12 | 15 | 1970 | 13 | 15 | 0052 | | | | | |
| 1000WE38U | | 05 | 2 | | 12 | 15 | 1970 | 13 | 15 | 0052 | 01 | 01 | 1971 | 08 | 00 | 0060 | | | | | |

Key: Examples
Error Code: 1000 Good Tape
Gage Name: WE38D (Col. 5 thru 9)
Punch: 05 5 minutes

Type: 1 = Precip., 2 = Runoff, 3 = Aquifer
Trace: 1 = On, 0 = Off
Translator Codes:

CHEK: Improper Tape Control
LIST: 1 = List Data, 0 = No
ITCH: 1 = Malf, 0 = OK
DATA: 1 = Loss Data, 0 = OK
ELE REF: Elev. of Aquifer

period (paper tape). Cards keypunched from the form serve as program controls during the computer reduction of the paper tape record. The form heading contains space for the State, the State watershed location number (IWID), watershed name, and year of data collection. Each record is identified as follows:

| Card Columns | Identification |
|---|---|
| 1-4 | The paper tape error code. |
| 5-16 | The gage location number. |
| 17-18 | The punchout time interval. |
| 19 | The type of data. |
| 20 | The trace indicator code. |
| 21-32 | Beginning time—month, day, year, hour, and minutes, respectively. |
| 33-36 | The first punched-data value. |
| 37-48 | Ending time—month, day, year, hour, and minute, respectively. |
| 49-52 | The last punched-data value. |
| 53 | Translation error codes. |
| 54-56 | Computer control codes. |
| 57-62 | Mean sea level (ground water recordings only). |

In addition to the above information, optional daily snowfall records are kept of days with precipitation other than rainfall. This record is used to identify days of solid precipitation on the computer output data. The information is recorded upon a snow date record form (table 3). This form contains the date and type of precipitation where the key at the bottom of the form explains the proper coding used under the "Type of Precipitation" column.

After the completion of rewinding, scanning, and identifying the paper tape records and the recording of appropriate information onto forms, the tapes are transported and stored in a 10 1/2-by-7 1/2-by-2-inch flat polyethylene freezer box. Each box can hold 1-year's record from 5-minute-interval gages.

*TABLE 3.—Snow date form table*

| Month | | Day | | Year | | Type | | Notes |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| 0 | 1 | 2 | 8 | 7 | 0 | N | | Example: Rain and Snow 1/28/70 |
| 0 | 2 | 0 | 1 | 7 | 0 | S | | Snow 2/1/70 |
| 0 | 3 | 1 | 5 | 7 | 0 | M | | Mixed Precipitation 3/15/70 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

Type Key: S = Snow
L = Sleet
M = Mixed Precipitation (Rain, Snow, Sleet)
N = Rain and Snow
H = Hail

## PAPER-TAPE-TO-MAGNETIC-TAPE TRANSLATION

Digital paper tape records in the original form cannot be used as direct input to digital computers without special interface equipment. Therefore, the paper tape data must be converted to a suitable media (usually cards or magnetic tape). This Center employs the paper-tape-to-magnetic-tape converting method.

The Digi-Data Model 1730 translator (fig. 8) uses sensing pins to read punched paper tape.[3] The information from the binary punched holes is converted to an equivalent four-digit number and electronically records this reading on a seven-channel, 556 BPI, IBM-compatible magnetic tape. Each four-digit number represents a 5- or 30-minute-interval gage reading, depending on the data being translated. The paper tape readings are converted to magnetic tape at a rate of 18 paper tape time intervals per second. The records are automatically blocked every 1,020 digits. An interrecord gap of three-fourths of an inch is written between each block. This blocking, combined with the interrecord gap, meets the requirements of most computer magnetic-tape reading devices.

The model 1730 contains a feature for entering fixed data settings of either 11 or four digits. Eleven windows are available to enable dialing a digit into each window. The individual digits can range from 0 to 9. Two controls, numbers 11 and 4, provide for writing an 11- or four-digit number on the magnetic tape.

The 11-digit control is available to enter the label information from the paper tapes being translated. This

[3]Digi-Data Corporation. Operation manual model 1730 converter (translator). 1970.

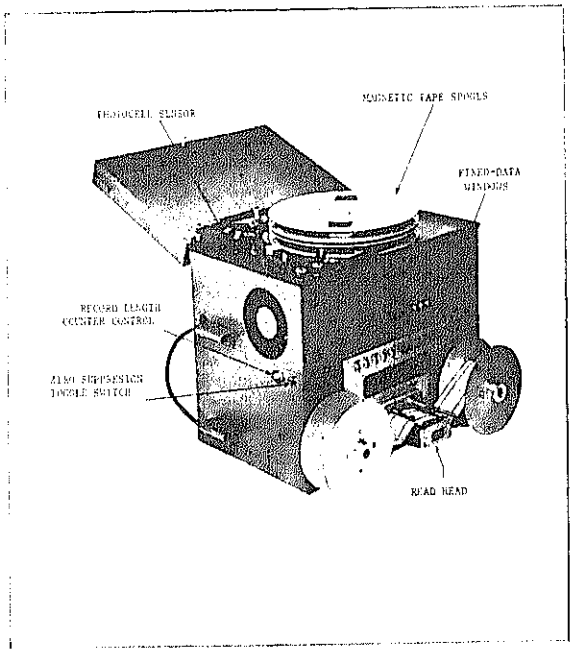



Figure 8.—A paper-tape-to-magnetic-tape translator.

method of entering the label information onto the magnetic tape is slow and provides opportunity for human error. Thus, the 11-digit control is not used with this translation procedure, since the label information will be fed into the computer through cards keypunched from the "Paper Tape Identification Form" (table 2).

The four-digit control has a twofold purpose. It is used to enter data from the paper tape record when misaligned punched readings cause the translator to stop. The value of the punched reading missed may be entered directly on the magnetic tape in the last four windows of the 11 windows. Since each paper tape record represents a different collection period and possibly a new error code, every paper tape record is translated as a separate record. To enable the computer to differentiate between paper tapes, a numerical code of 9999 is written on the magnetic tape through the use of the number 4 digit control. The "four 9's" code signals the end of a paper tape record and is applied after each paper tape's translation.

The original design of the model 1730 translator was such that zero gage readings, nonpunched values, could not be read. This feature allowed the translator to stop translation of a paper tape when the 6-inch blank span at the end of the paper tape was encountered. The ability to translate zero readings is necessary when precipitation data are being converted.

The construction of the precipitation gage is such that after a collection of 15.0 to 19.9 inches of precipitation, the collector part must be emptied and the following recording period begun with zero gage readings. These zero readings will be present on the paper tape until the first precipitation event. To provide for precipitation data translation, the model 1730 was modified by installation of a "zero suppression" toggle switch. This switch resides in one of two positions, normal or nonnormal. The normal position does not allow the translator to read zero values, thus stopping translation on encounter with unpunched tape, and the nonnormal position allows translation of zero gage values.

The procedure for paper-tape-to-magnetic-tape translation can vary with the model 1730, but with ease of operation and speed as a criteria, the following step-by-step procedure is recommended:

1. Load the magnetic tape on a supply spool that is located on top of the translator and hand threaded through the proper path to a takeup spool. A tape-loading diagram is supplied by the manufacturer. The tape spools handle varied sizes of computer magnetic tape up to 10 1/2-inch reels.
2. Set *Recorder Mode Switch* to the *record* position and turn power on. The function of the *Recorder Mode Switch* is to specify one of the following three options: *record, rewind,* and *fast forward wind.*
3. Press the *Record Length Counter* (RLC) control. This control energizes the magnetic tape blocking counter. Every 1,020 digits are blocked, plus an interrecord gap on the magnetic tape, by the automatic blocking feature.
4. Press *Begin of Magnetic Tape* (BOT) control. The magnetic tape advances until a photocell sensing light encounters an aluminum foil reflective mark attached to the tape some 10 feet into the supply spool. The mark provides an exact starting point for recording, which enables a computer-tape-read device to index at the proper beginning of the magnetic tape data.
5. Set *Zero Suppression Switch* to the normal position if reading nonzero paper tape data. Set to the nonnormal position to read data with beginning zero values.
6. Load first paper tape record onto the translator-read head. The beginning of record on the paper tape, as identified by the red marker line, is aligned so as to be the first punched value

read and converted. Proper indexing of this line assures the appropriate beginning clock and paper tape time synchronization.

7. Press *Start Control Button.* The paper-tape-to-magnetic-tape conversion continues until the end of the paper tape is encountered. The position of the *Zero Suppression Switch* is important during the translation. If the switch position was nonnormal at the start of translation, it must be placed at the normal position as soon as the first nonzero punched values appear in the paper tape. If the translation stops because of misaligned paper tape punches, the value of the reading prior to the stop point is dialed into the last (most right hand) four fixed-data windows, and the number 4 control is pressed. This reading is converted to the magnetic tape. Repress the *Start Control.* Translation will continue until the blank span at end of paper tape automatically stops translator.
8. Remove the paper tape from the translator-read head. Dial 9999 code into the last four fixed-data windows and press 4 control. This code is applied after the translation of each paper tape. A paper tape requires from 4 to 6 minutes for loading, translation, and removal.
9. Place two end-of-file marks, by means of an *EOF Control,* when the last paper tape record for the run has been translated, and the four 9's code has been applied. The end-of-file marks are recognized by the computer as the end of all data on the magnetic tape. The feature is used only as an end of all data.
10. Place the *Record Mode Switch* in the *Rewind position* after completion of the translation. The magnetic tape rewinds onto the supply spool and is removed, identified, and stored prior to computer reduction.

## TRANSLATION PROCEDURE ERRORS

The translation procedure can provide some opportunities for human error. A translator operator may mistakenly write on the magnetic tape an incorrect control code at the end of a paper tape. The operator, realizing that the error may have occurred, can take appropriate steps to have the computer correct the error by use of the proper numerical code from table 4.

*TABLE 4.—Translator operator errors*

(Coded in Column 53, Paper Tape Identification Form)

| Code | Type of Translator Operator Error |
|---|---|
| 0 or Blank | No errors during paper tape translation. |
| 1 | The four 9's, or EOF end-of-paper-tape control, left off magnetic tape after the paper tape translation. |
| 2 | Two end-of-paper-tape controls of four 9's or EOFs were mistakenly written on magnetic tape. |
| 3 | A value other than the four 9's or EOF control was written on magnetic tape. |
| 4 | The "Zero Suppression" switch left in the nonnormal position. Paper tape continued to run, extra zeros on magnetic tape. The four 9's or EOF control was placed at end of the zeros. |
| 5 | The same problem as Code 4, except failed to write the four 9's control on magnetic tape at end of zeros. |

The desired code is entered in column 53 of the Paper Tape Identification Form (table 2), opposite the paper tape on which the error occurred. Any code from table 4, other than zero or blank, tells the computer to use a supplied ending date and time to determine the end of a paper tape. If the instrument error code (App. 1) for the paper tape is 1,000, with good data tape with no apparent errors, the supplied ending date and time for the tape would be the same as the ending date and time shown on the tape label.

When the instrument error code specifies a time gain or loss, a manually calculated ending date and time for the paper tape must be determined. This calculation is performed as follows: (a) Count the number of punchout intervals for the paper tape period, which will give the number of 5- or 30-minute intervals for the tape period. (b) Divide the count into days, hours, and minutes, and add to the paper tape's beginning punchout date and time, which establishes the actual tape punchout ending date and time. (c) Keypunch this time on a data card. The description of this extra card (Translator Error Card) is given in the next section.

## COMPUTER INPUT DATA

The computer input consists of both keypunch cards and the translator-produced magnetic tape. The cards are standard 80-column punchcards. The input card variables, proper coding of these variables, and the type of format are described under each card layout. The following format code is adhered to:

I = Integer number, right justified in card field.
F = Real number, contains a decimal point location. Decimal point not punched on the card.
A = Alphanumeric, number or letter, left justified in the card field.
X = Blank card field, not used.

## CARD LAYOUTS

### Header Card

(One Card–Required)

| Variable | NHEAD | NSC |
|---|---|---|
| Format Code | I1 | I3 |
| Card Columns | 1 | 2-4 |

| Variable | Description |
|---|---|
| NHEAD | The number of "page heading cards" to be read and written as headings on each computer output page. A maximum of three "page heading cards" may be read and written. This code is zero if no page headings are to be written on the printer. |
| NSC | The number of "snow date cards" to be read into storage. A zero coding indicates no "snow date cards" to be read. A maximum of 999 cards may be read. (See snow date card layout below). |

### Page Heading Cards

(A maximum of three cards, the number of cards must equal to NHEAD on the "Header Card"). (If NHEAD equals zero, this card layout is not needed).

| Variable | HCARD(x)[1] |
|---|---|
| Format Code | 54A1 |
| Card Columns | 1-54 |

[1]The "x" notates an integer from 1 through 3.

| Variable | Description |
|---|---|
| HCARD | Output Identification (See example below). Example: "Basic Precipitation Data (Break Point)" for HCARD (1). "NEWRC, University Park, Pa.", for HCARD (2). "_____", for HCARD (3). Note: The State, watershed, and gage names are automatically written following the page headings. These variables receive values from the following control and label card layouts. |

## Snow Date Card

(Optional cards, use by precipitation data only, one card for each day of precipitation other than snow).

Note: If NSC on header card is zero, this card layout is not needed.

| Variable | NSDTE(x,1)[2] | NSDTE(x,2)[2] | NSDTE(x,3)[2] | STYPE(x)[2] |
|---|---|---|---|---|
| Format Code | I2 | I2 | I2 | A1 |
| Card Columns | 1-2 | 3-4 | 5-6 | 7 |

[2]Numbers in parentheses represents indexes of computer storage tables, The "x" denotes a number beginning with 1 and ascending to 999. This provides storage for a possible 999 days of snowfall or similar precipitation.

| Variable | Description |
|---|---|
| NSDTE (x,1) | The month. |
| NSDTE (x,2) | The day. |
| NSDTE (x,3) | The last two digits of the year. |
| STYPE (x) | The type of precipitation, see "snow date" form (table 1) for proper coding. |

The snow date cards are punched directly from the "snow date record form" on table 3.

The following card layouts serve as program control and paper tape records information. The main portion of the card variables described obtain values from the "paper tape identification form" (table 2). Cards may be keypunched directly from this form.

## Control Card

(One card for each different gage's paper tape records contained on the translator magnetic tape) (Required).

| Variable | STATE | IWID | WSH | GAGE | NPFG | NTPT | IEOF |
|---|---|---|---|---|---|---|---|
| Format Code | A3 | I4 | 16A1 | 3A4 | I2 | I2 | I1 |
| Card Columns | 1-3 | 4-7 | 8-23 | 24-35 | 36-37 | 38-39 | 40 |
| | IT | KT | OUT2 | NSKIP | NOEOF | KT1 | KT2 |
| | I2 | I2 | A6 | I1 | I2 | I2 | I2 |
| | 41-42 | 43-44 | 45-50 | 51 | 52-53 | 54-55 | 56-57 |
| | KT3 | KT4 | NDST | NEWDAT | IGREF | | |
| | I2 | I2 | I1 | I1 | I4 | | |
| | 58-59 | 60-61 | 62 | 63 | 64-67 | | |

| Variable | Description |
|---|---|
| STATE | The abbreviated State name, (example: Pennsylvania = Pa.). |
| IWID | The State watershed location number (example: Mahantango Ck., Pa. = 1601). |
| WSH | The watershed name (example: Mahantango Ck.). |
| GAGE | The gage location identification (example: Gage = RE38) (Maximum of 12 characters). |
| NPFG | The number of paper tape records for the gage (example: NPFG = 12, paper tape records for the period are 12). |

| Variable | Description |
|---|---|
| NTPT | The total number of paper tape records on the translator magnetic tape. This variable will be coded the same on each control card for the process. |
| IEOF | If 9999 (four 9's) is written on translator tape after each paper tape, IEOF = 0. If end-of-file marks (EOF) are written after each paper tape, IEOF = 1. |
| IT | The computer-read unit number on which the translator tape will be mounted during processing (Example: IT = 01). |
| KT | The computer-write unit number on which the output storage magnetic tape will be mounted. (Example: KT = 03). |
| OUT2 | The magnetic tape volume name on which the output storage data will be written (Example: OUT2 = MAH333). |
| NSKIP | When coded as 1, this variable will initiate a readout of a specified number of paper tape records from the translator tape. The paper tapes read will be ignored, and processing will commence on the paper tape immediately following the last paper readout. The number of paper tapes to be read out will be coded under the following NOEOF variable. If no paper tape records are to be skipped, NSKIP will be coded as zero, and processing will begin on the first paper tape. |
| NOEOF | The number of paper tape records to be skipped on readout if NSKIP equals 1. NOEOF equals zero if NSKIP equals zero. |
| KT1, KT2, KT3, and KT4 | These variables are control codes used by the computer in writing an end-of-file on the output storage magnetic tape or tapes at completion of processing. The proper coding for these variables would be the same as the "KT" variables used on any or all control cards. (Example: KT1 = 03, because one magnetic storage tape is used and the tape to be end-filed is KT = 03). A maximum of four output storage tapes may be used during one processing. Each would be end-of-filed at end of process. |
| NDST | This code is used in special cases where a dual-control, stream gaging station exists, one control for measuring low flows and another for measuring high flows. In this special case, NDST would be coded as zero for the high-flow control and as 1 for the low-flow control. When runoff data is from a single control station, NDST would be coded as zero. The NDST code is used in later processing to identify the proper rating table or curve to be used in computing discharge. |
| NEWDAT | This variable, when coded 1, specifies that a different type of hydrologic data will follow the present data. A new header card must be read following the last paper tape record of this control card. NEWDAT will be coded zero if same type of data is to follow. |
| IGREF | The maximum change in gage-recorded amount that may occur in a given time interval, or maximum gage height allowed. This variable is necessary because of the possibility of erroneous punchouts on the paper tape by the digital-recording gage. If any gage-punched reading for a given time interval exceeds the value of this variable, the data is considered invalid and is ignored by the computer. Default values for the three types of hydrologic data will be used when IGREF equals zero. These defaults are as follows: (a) a maximum of 1-inch change in precipitation amount in a 5-minute interval, (b) a maximum of 30.00-foot gage depth for any runoff amount, (c) a maximum of 60.00-foot gage depth for any ground water level. |

## Label Card

(One card for each paper tape record contained on the translator tape) (Required).

Note: The card columns of this card are identical to the columns of the "paper tape identification form."

| Variable | NCOD | GAG | NPIL | NTYPE | NTRACE |
|---|---|---|---|---|---|
| Format | I4 | 3A4 | I2 | I1 | I2 |
| Card Columns | 1-4 | 5-16 | 17-18 | 19 | 20 |
| | MT1 | ND1 | NY11 | NY1 | NH1 |
| | I2 | I2 | I2 | I2 | I2 |
| | 21-22 | 23-24 | 25-26 | 27-28 | 29-30 |
| | NMI | ARD1 | MT2 | ND2 | NY22 |
| | I2 | FH.2 | I2 | I2 | I2 |
| | 31-32 | 33-36 | 37-38 | 39-40 | 41-42 |
| | NY2 | NH2 | NM2 | ARD2 | ICHECK |
| | I2 | I2 | I2 | F4.2 | I1 |
| | 43-44 | 45-46 | 47-48 | 49-52 | 53 |
| | NLIST | ITCHG | LDATA | ELEREF | |
| | I1 | I1 | I1 | F6.2 | |
| | 54 | 55 | 56 | 57-62 | |

| Variable | Description |
|---|---|
| NCOD | The gage malfunction error code for the paper tape record. (Example: NCOD 1,000 is good data) (See Error Codes, App. 1). |
| GAG | The gage location identification, this variable is coded the same as "GAGE" on the control card for this gage (Example: RE38 _____ ). |
| NPIL | The paper tape punchout time interval (Example: 05 for a 5-minute punch interval). |
| NTYPE | The type of data being processed, NTYPE will equal 1 for precipitation, 2 for streamflow, and 3 for ground water data. |
| NTRACE | If the rain-trace sensor on a rain gage is in operation for the paper tape, NTRACE = 1, if sensor out of operation, NTRACE = 0. If processing runoff or ground water data, NTRACE = 0. |
| MT1 | The paper tape beginning month. |
| ND1 | The paper tape beginning day. |
| NY11 | The first two digits of the beginning year (Example: 1970, NY11 = 19). |
| NY1 | The last two digits of the beginning year (Example: 1970, NY1 = 70). |
| NH1 | The beginning hour (military watch time, 24 for midnight). |

| Variable | Description |
|---|---|
| NM1 | The beginning minutes. (This variable should be a multiple of 5 or 30). (Example: If NM1 = 15 for 15 minutes after the hour, the paper tape time cycle is every 5 minutes). |
| ARD1 | The beginning punchout reading (Example: 000.0 = zero precipitation, 01.00 = 1 foot of stream depth, etc.). (Decimal point not punched; therefore, data must be right justified about the decimal point). |
| MT2 | The paper tape ending month. |
| ND2 | The ending day. |
| NY22 | The first two digits of the ending year. |
| NY2 | The last two digits of the ending year. |
| NH2 | The ending hour (military watch time). |
| NM2 | The ending minutes (a multiple of 5 or 30). |
| ARD2 | The ending punchout reading (decimal point not punched). |
| ICHECK | The coding of this variable pertains to the end of paper tape control of four 9's. The proper coding is found under the "translator operator errors" in table 4 and Column 53 of the paper tape identification for table 2. (See "Translator Error Card" below). |
| NLIST | Used on runoff or ground water data only. If all output records are to be listed on a printer, NLIST will equal 1. If only the page headings, the first and last record for each paper tape period and a summary for each paper tape are to be printed on output, NLIST will equal zero. The precipitation data is automatically listed, and in this case, NLIST would be coded as zero. |
| ITCHG | If a precipitation trace sensor malfunction under "NCOD" above occurred during the record period, and if the trace sensor is to be ignored, ITCHG would be coded as 1. ITCHG would equal zero in all other cases. |
| LDATA | This variable describes the number of comment cards (loss data cards) that are to be read immediately following this label card or a translator error card, if present (LDATA may have a value of zero through 9). If LDATA is equal to zero, no loss data cards will be read. |
| ELEREF | Used by ground water well data only. This variable is coded with the value of mean sea level elevation when the top of a ground water well is reference to elevation. The output data would be values of elevation in place of gage-reading depths. If the well is not referenced to mean sea level elevation, the variable ELEREF would be coded as zero, and the output would be gage-reading water depths in feet. The maximum elevation of a well at ground level is 9999.99 feet (Decimal point not punched). |

The following cards can be inserted in the input data card deck immediately following the paper tape label card. The first, a "Translator Error Card," will be needed in the event that a translator operator's error occurred at the time of translation, and the gage malfunction error code (NCOD) is for a time gain or loss. The second, "Loss Data Cards," can be used to note a period of data loss between or during paper tape collection periods.

## Translator Error Card

(Optional card after a label card)

Note: If "ICHECK," under Label Card above does not equal zero for the paper tape record, this card must be present in the input deck. The format of this card coincides with the format of the "Label Card" above.

| Variable | BLANK | IMO | IDA | IY | IYR | IHR | IMN |
|---|---|---|---|---|---|---|---|
| Format | 36X | I2 | I2 | I2 | I2 | I2 | I2 |
| Card Columns | 1-36 | 37-38 | 39-40 | 41-42 | 43-44 | 45-46 | 47-48 |

| ARED |
|---|
| F4.2 |
| 49-52 |

| Variable | Description |
|---|---|
| BLANK | 36 blanks are not used. These blanks orient the card variables to coincide with the "Label Card" format. |
| IMO | The computed-paper-tape-record ending month (See "Translation Procedure Errors" Section). |
| IDA | The computed-paper-tape-record ending day. |
| IY | The first two digits of the computed-tape ending year (Example: 1970, IY = 19). |
| IYR | The last two digits of the computed-tape ending year (Example: 1970, IYR = 70). |
| IHR | The tape ending hour (military time). |
| IMN | The tape ending minutes (IMN must be a multiple of 5 or 30). |
| ARED | The ending punch-out value (Decimal not punched). |

## Loss Data Cards

(Optional cards after the "Translator Error Card" or "Label Card"). These cards are used to note a loss of data between two paper tapes.

Note: A maximum of nine cards allowable.

| Variable | ACARD |
|---|---|
| Format | 80A1 |
| Card Columns | 1-80 |

| Variable | Description |
|---|---|
| ACARD | Comments for output on the data listing. The "LDATA" code under the label card layout must be greater than zero to read "Loss Data Cards." The number of loss data cards read and printed will equal the LDATA code from the label card of the preceding paper tape. |

## ORDER OF INPUT

The Input Data Cards are stacked in the following order:

1. Header Card (one card, required).
2. Page-Heading Cards (maximum of three cards, optional).
3. Snow Date Cards (maximum of 999 cards, optional).
4. Control Card (one card, required).
5. Label Card (one card, required).
6. Translator Error Card (one card, optional).
7. Loss Data Card (maximum of nine cards, optional).
8. Repeat steps 5 through 7 for each paper tape record for a gage.
9. Repeat steps 4 through 8 for each gage's data.
10. Repeat steps 1 through 9 for each type of data on the translator magnetic tape.

(A typical stacking order is illustrated in figure 9.)

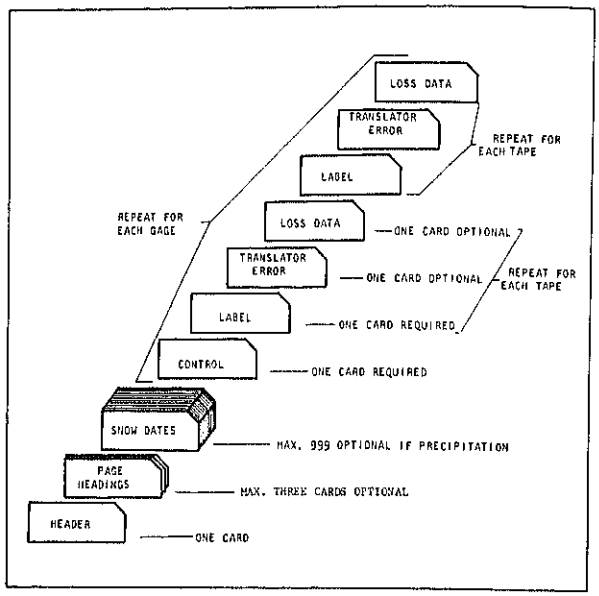



Figure 9.–A typical input-data-cards stacking order.

The translator magnetic tape contains the basic input data. The physical makeup of this tape is a long, continuous string of digits, each four digits representing a 5- or 30-minute-interval data entry. An imaginary decimal point is located between the third and fourth digits for precipitation data and between the second and third digits for runoff and ground water data. The presence of a number 8 in the first digit of a precipitation reading signals a trace sensor indicator. The occasional appearance of four 9's represents an end of a paper tape record. Following every 1,020 digits, a blank space and unprinted line indicate an interrecord gap. A pictorial view of a section of data listed from a translator magnetic tape is illustrated in figure 10. A "box" encloses a group of four 9's to aid recognition.

The combination of input cards and translator magnetic tape completes the input data requirement of the processing computer program.

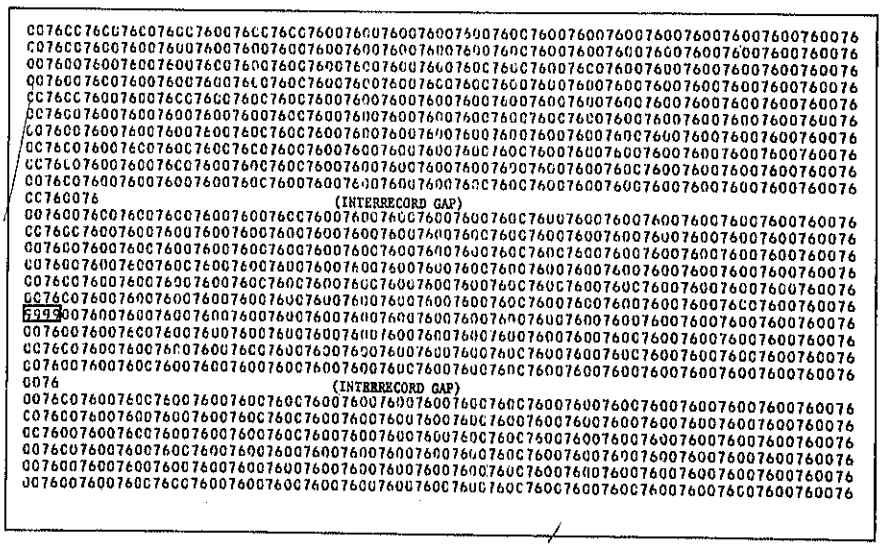



Figure 10.–A pictorial view of a section of data listed from a translator magnetic tape.

## COMPUTER SOURCE PROGRAM

The computer program developed to reduce the digital hydrologic data was written in Fortran IV language for use on an IBM 360/67 computer system.[4] This source program is comprised of a main program and nine subroutine subprograms to aid in program "debugging" and because of their ease in following the program's flow direction.

A major function of the program is to edit the data for extraneous gage readings from the translator magnetic tape and to retain only those gage readings that are needed to reproduce the hydrologic events for a record period. These values with appropriate date and time, gage malfunction error code, and other identifying information are listed on a printer and written on magnetic tape storage as output. A complete errors edit is performed using information from the Translator Operator's Error or Loss Data Cards.

The appropriate action is taken by the program to identify these errors by printed messages on the output media. The program does not attempt corrections of gage malfunction errors. The error codes provide sufficient information for a later step in data correction and analysis. The program was written to enable the reduction of all three types of digital hydrologic data: streamflow, precipitation, and ground water wells.

A normal method would be to reduce each type of data separately, avoiding a mixture of the three types of data on a single magnetic storage tape.[5] One type of data per storage tape provides a less complicated data retrieval at a later date. A source program and input-data loading order is illustrated in figure 11. The // and /* cards are computer residence cards, which can vary from one computational center to another. A listing of the program is given in Appendix II.

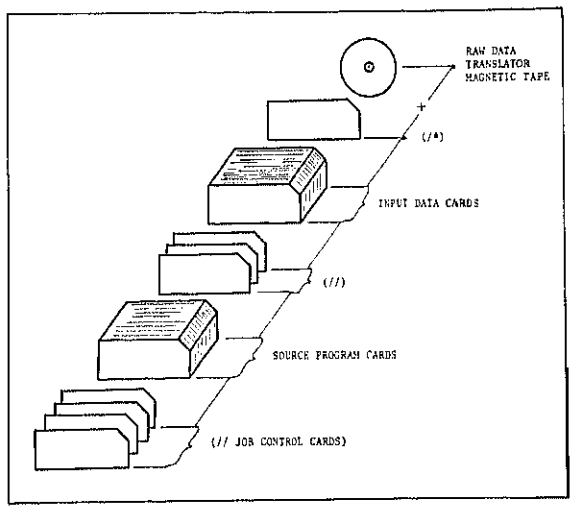



Figure 11.–A diagram of the computer source program and input-data loading order.

## TRANSLATOR MALFUNCTIONS AND THEIR COMPUTER CORRECTIONS

The paper-tape-to-magnetic-tape translator places data on the magnetic tape in a binary-coded decimal form. The signal strength of each digit must lie within the acceptable signal strength range of the computer device used to read the magnetic tape. It has been found with the Model 1730 translator that the signal strength of an individual digit occasionally may fall outside this acceptable range. Consequently, an invalid character is usually substituted for the correct 0-to-9 digit.

This invalid character will cause the program to stop execution, and the data on the magnetic tape beyond this point becomes inaccessible in the current job step. This character results in an error code IHC215I on the IBM 360/67 system. It can be bypassed by the use of the ERRSET subroutine. An example of the invalid character might be 01'3 instead of 0123. The ERRSET statement simply informs the computer to take the invalid character (') and to convert it to a valid digit (1). This results in a usable four-digit number (0113). The one digit is obtained from the last argument in the CALL ERRSET statement. Likewise, the second argument (256) allows for 256 of the IHC215I errors before program execution is completely terminated. The values of these two arguments is arbitrary within certain limits (See Ref. No. 3).

A second translator malfunction that can occur with the model 1730, although less frequently, is a permanent input error (IBM-IHC218I). This error is also produced from a weak signal on the translator mag-

[4]IBM Corporation. IBM system/360 operating system, Fortran IV (G) Programmer's Guide. File No. S360-25, Form No. C28-6639-1. 1966.

[5]Shanholtz, V. O., and Burford, J. B. Computer systems for reduction and analysis of hydrologic data. U.S. Dept. Agr., Agr. Res. Serv., ARS 41-132. 1967.

netic tape. When the computer attempts to read a record and is unable to recognize the value as valid, the ERR = argument of the input data READ statement (main program, App. II) instructs the computer to reread the record in error. The record is reread numerous times in an attempt to receive a valid value. If a recognizable value is obtained, the program execution continues. If not, execution fails, and the processing stops.

Following the use of either of these correction routines, the computer reduction program is designed to ignore the corrected record if its value is above or below a set amount when compared with the preceding and following record.

However, the occurrence of these malfunctions is rare. The use of very high-quality magnetic tape in the translation process can help to reduce the possibility of a translator malfunction.

## COMPUTER OUTPUT DATA

The output data from the computer reduction step can be written via a printer and/or placed on permanent magnetic storage tape.

An example of the printer output is given in figure 12 and illustrates one paper tape record period from Rain gage RR-44, Mahantango Creek Watershed. The collection period began 9/9/69 at 1020 with zero rainfall and ended 10/7/69 at 1100 with 2.6 inches of accumulated rainfall. During this period, the rain trace indicator was in operation and is noted on the records with a "T" as trace rainfall. The "type" column is blank, because only rainfall was measured, not snowfall or other similar precipitation.

The blank line spaces across the listing are rainfall event separators. These represent an hour or more between the end of one rain and the beginning of another. The footnotes describe the computer versus the watch-time ending of the paper tape, the number of basic records written on magnetic tape, the number of records read and analyzed, and the type of rain gage malfunction error for the collection period.

The streamflow output listing (fig. 13) depicts a recording period of 6 days from stream gage WE38U. In this example, the "list" option, described as "NLIST" in the "Computer Input Data" section, is in effect. The output is similar to the precipitation listing in Gage No., Date, Time, and Code columns. The "Time Intr" column represents the number of 5-minute intervals during which the stream level remained at the corresponding gage depth under the "Depth (FT)" column. The presence of zero in the "Discharge Table No" column indicates that the data record is from a large control of a "dual-control gaging station." The footnotes follow the same format as that in the precipitation data listing.

The printed output from ground water well data as shown (fig. 14) is generally the same as output from streamflow. This output is also a result of the "List" option effect. The "NREFE" column indicates, by the presence of a blank, that gage depths are actual instrument readings not referenced to M.S.L. elevation. Every 2400-hour reading for the entire record period is listed and written on the magnetic tape for both the ground water and the streamflow data.

When the list option (NLIST) is coded as zero, the printed output for each ground water well or streamflow paper tape will contain only the page and column headings, the first and last record written on magnetic tape storage, and footnote information. This option of zero or no listing allows the summary of the paper tape information without printing all basic output records, thus decreasing the initial processing time. A listing of the basic output records may be obtained from the magnetic storage at some later date.

The magnetic storage tapes contain only the basic output records. These records are written in an unformated form, or format-free output. Each integer or real variable of a record requires four bytes of magnetic storage, and every character of a literal character string requires one byte, plus four extra computer-required bytes for each record written. The storage requirements for each precipitation record, streamflow, and ground water well are the same: 56 bytes. The magnetic tape is written in blocked records of 100 records per block, and the variable block size (VBS) needed to store the different length records is 6,004 bytes, including four extra bytes per block.

The Fortran IV naming convention must be followed when reading or writing unformated records on

PRECIPITATION(BREAK POINT BASIC DATA)
NEWRC,UNIVERSITY PARK,PA.
STATE-PA. STATE IND. NO.=1600

WATERSHED= MAHANTANGO CR. GAGE=RR44

| GAGE NO. | MONTH | DAY | YEAR | TIME HR | TIME MIN | TRACE | PRECIP DEPTH FOR INTERVAL (INCHES) | TYPE | PRECIP ACC. (INCHES) | CODE |
|---|---|---|---|---|---|---|---|---|---|---|
| TAPE BEGINNING DATE,TIME,READING= 9/ 9/1969 1020 0.0 | | | | | | | | | | |
| RR44 | 9 | 17 | 1969 | 16 | 35 | T | 0.0 | | 0.0 | 1000 |
| RR44 | 9 | 17 | 1969 | 16 | 40 | | 0.2 | | 0.2 | 1000 |
| RR44 | 9 | 17 | 1969 | 17 | 10 | | 0.1 | | 0.3 | 1000 |
| RR44 | 9 | 17 | 1969 | 17 | 25 | | 0.1 | | 0.4 | 1000 |
| RR44 | 9 | 17 | 1969 | 17 | 45 | | 0.1 | | 0.5 | 1000 |
| RR44 | 9 | 17 | 1969 | 17 | 50 | | 0.1 | | 0.6 | 1000 |
| RR44 | 9 | 17 | 1969 | 22 | 45 | T | 0.0 | | 0.6 | 1000 |
| RR44 | 9 | 17 | 1969 | 23 | 0 | | 0.1 | | 0.7 | 1000 |
| RR44 | 9 | 17 | 1969 | 23 | 50 | | 0.1 | | 0.8 | 1000 |
| RR44 | 9 | 25 | 1969 | 13 | 55 | | 0.1 | | 0.9 | 1000 |
| RR44 | 9 | 27 | 1969 | 21 | 40 | T | 0.0 | | 0.9 | 1000 |
| RR44 | 9 | 27 | 1969 | 22 | 35 | | 0.1 | | 1.0 | 1000 |
| RR44 | 9 | 28 | 1969 | 7 | 20 | T | 0.0 | | 1.0 | 1000 |
| RR44 | 9 | 28 | 1969 | 7 | 35 | | 0.1 | | 1.1 | 1000 |
| RR44 | 10 | 2 | 1969 | 9 | 55 | T | 0.0 | | 1.1 | 1000 |
| RR44 | 10 | 2 | 1969 | 10 | 25 | | 0.1 | | 1.2 | 1000 |
| RR44 | 10 | 2 | 1969 | 11 | 5 | | 0.1 | | 1.3 | 1000 |
| RR44 | 10 | 2 | 1969 | 12 | 5 | | 0.1 | | 1.4 | 1000 |
| RR44 | 10 | 2 | 1969 | 13 | 15 | T | 0.0 | | 1.4 | 1000 |
| RR44 | 10 | 2 | 1969 | 13 | 35 | | 0.1 | | 1.5 | 1000 |
| RR44 | 10 | 2 | 1969 | 14 | 40 | T | 0.0 | | 1.5 | 1000 |
| RR44 | 10 | 2 | 1969 | 14 | 45 | | 0.1 | | 1.6 | 1000 |
| RR44 | 10 | 2 | 1969 | 15 | 40 | | 0.1 | | 1.7 | 1000 |
| RR44 | 10 | 2 | 1969 | 16 | 0 | | 0.1 | | 1.8 | 1000 |
| RR44 | 10 | 2 | 1969 | 17 | 10 | T | 0.0 | | 1.8 | 1000 |
| RR44 | 10 | 2 | 1969 | 17 | 25 | | 0.1 | | 1.9 | 1000 |
| RR44 | 10 | 2 | 1969 | 18 | 30 | | 0.1 | | 2.0 | 1000 |
| RR44 | 10 | 2 | 1969 | 19 | 0 | | 0.1 | | 2.1 | 1000 |
| RR44 | 10 | 2 | 1969 | 19 | 55 | | 0.1 | | 2.2 | 1000 |
| RR44 | 10 | 2 | 1969 | 20 | 55 | | 0.1 | | 2.3 | 1000 |
| RR44 | 10 | 2 | 1969 | 23 | 10 | T | 0.0 | | 2.3 | 1000 |
| RR44 | 10 | 3 | 1969 | 0 | 10 | | 0.1 | | 2.4 | 1000 |
| RR44 | 10 | 3 | 1969 | 1 | 20 | T | 0.0 | | 2.4 | 1000 |
| RR44 | 10 | 3 | 1969 | 1 | 25 | | 0.1 | | 2.5 | 1000 |
| RR44 | 10 | 3 | 1969 | 2 | 10 | | 0.1 | | 2.6 | 1000 |

END OF TAPE NO.31,FOR GAGE-RR44 END OF TAPE ON LABEL=10/ 7/1969 TIME=11 0 READING= 2.6
END OF TAPE COMPUTED=10/ 7/1969 TIME=11 0 READING= 2.6

THE NO. OF RECORDS WRITTEN= 44
THE TOTAL NO. OF PUNCHES FOR PAPER TAPE WAS COMPUTED TO BE= 8073 PUNCH INTERVAL= 5

DATA FOR PAPER TAPE WRITTEN ON TAPE NO.VA1314,FOR STORAGE-- THE ERROR CODE FOR TAPE=1000
ERROR CODE (1000) GOOD DATA TAPE NO APPARENT ERRORS

Figure 12.--An example of printer output from one precipitation record.

STREAM FLOW (BREAK POINT BASIC DATA)
NEWRC, UNIVERSITY PARK,PA.

STATE-PA. STATE IND. NO.=1606

WATERSHED= MAHANTANGO CK. GAGE=WE38U

| | GAGE NO. | MONTH | DAY | YEAR | TIME HR | TIME MIN | TIME INTR | DISCHARGE TABLE NO. | DEPTH (FT) | CODE |
|---|---|---|---|---|---|---|---|---|---|---|
| BEGIN OF TAPE LABEL= | WE38U | 10 | 6 | 1970 | 12 | 50 | | | 0.23 | 1000 |
| FIRST RECORD ON MAG.= | WE38U | 10 | 6 | 1970 | 12 | 50 | 12 | 0 | 0.23 | 1000 |
| | WE38U | 10 | 6 | 1970 | 12 | 50 | 12 | 0 | 0.23 | 1000 |
| | WE38U | 10 | 6 | 1970 | 13 | 50 | 24 | 0 | 0.22 | 1000 |
| | WE38U | 10 | 6 | 1970 | 15 | 50 | 46 | 0 | 0.21 | 1000 |
| | WE38U | 10 | 6 | 1970 | 19 | 40 | 52 | 0 | 0.20 | 1000 |
| | WE38U | 10 | 6 | 1970 | 24 | 0 | 203 | 0 | 0.20 | 1000 |
| | WE38U | 10 | 7 | 1970 | 16 | 55 | 85 | 0 | 0.19 | 1000 |
| | WE38U | 10 | 7 | 1970 | 24 | 0 | 123 | 0 | 0.19 | 1000 |
| | WE38U | 10 | 8 | 1970 | 10 | 15 | 54 | 0 | 0.20 | 1000 |
| | WE38U | 10 | 8 | 1970 | 14 | 45 | 111 | 0 | 0.19 | 1000 |
| | WE38U | 10 | 8 | 1970 | 24 | 0 | 117 | 0 | 0.19 | 1000 |
| | WE38U | 10 | 9 | 1970 | 9 | 45 | 53 | 0 | 0.20 | 1000 |
| | WE38U | 10 | 9 | 1970 | 14 | 10 | 118 | 0 | 0.19 | 1000 |
| | WE38U | 10 | 9 | 1970 | 24 | 0 | 70 | 0 | 0.19 | 1000 |
| | WE38U | 10 | 10 | 1970 | 5 | 50 | 204 | 0 | 0.20 | 1000 |
| | WE38U | 10 | 10 | 1970 | 22 | 50 | 14 | 0 | 0.19 | 1000 |
| | WE38U | 10 | 10 | 1970 | 24 | 0 | 27 | 0 | 0.19 | 1000 |
| | WE38U | 10 | 11 | 1970 | 2 | 15 | 261 | 0 | 0.20 | 1000 |
| | WE38U | 10 | 11 | 1970 | 24 | 0 | 203 | 0 | 0.20 | 1000 |
| LAST RECORD ON MAG= | WE38U | 10 | 11 | 1970 | 24 | 0 | 1 | 0 | 0.20 | 1000 |

END OF TAPE NO. 1,FOR GAGE=WE38L
END OF TAPE ON LABEL=10/12/1970 TIME=17 0 READING= 0.19
END OF TAPE COMPUTED=10/12/1970 TIME=17 0 READING= 0.19
THE NO. OF RECORDS WRITTEN= 18

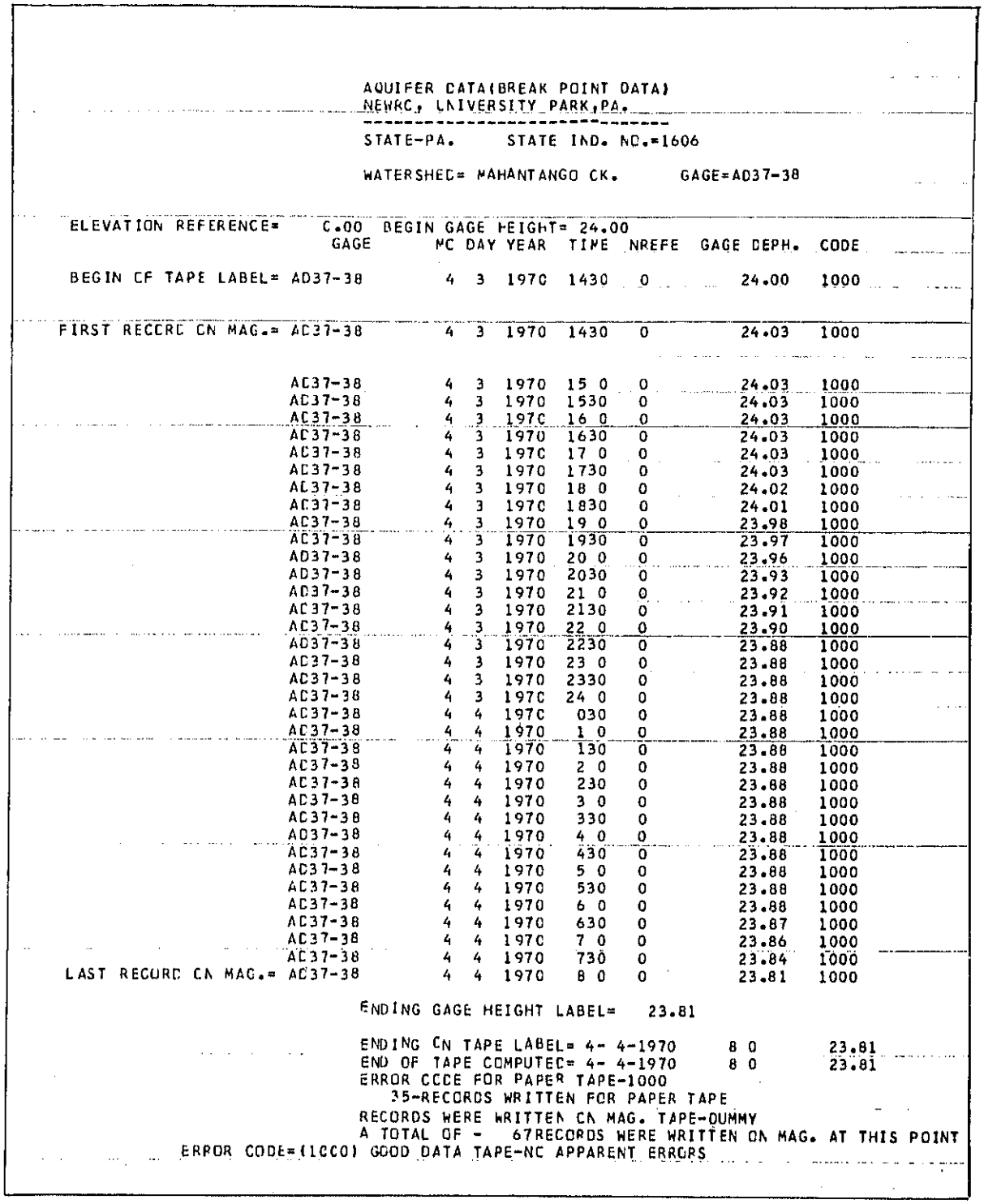
TOTAL RECORDS WRITTEN ON MAG. TAPE SINCE BEGINNING= 1242

THE TOTAL NO. OF PUNCHES FOR PAPER TAPE WAS COMPUTED TO BE= 1779 PUNCH INTERVAL= 5

DATA FOR PAPER TAPE WRITTEN ON TAPE NO.DUMMY ,FOR STORAGE-- THE ERROR CODE FOR TAPE=1000

ERROR CODE=(1CCO) GOOD DATA TAPE-NO APPARENT ERRORS

Figure 13.—An example of printer output for one streamflow paper tape record.



```
                    AQUIFER DATA(BREAK POINT DATA)
                    NEWRC, UNIVERSITY PARK,PA.
                    ---------------------------
                    STATE-PA.      STATE IND. NO.=1606

                    WATERSHED= MAHANTANGO CK.        GAGE=AD37-38

ELEVATION REFERENCE=    0.00  BEGIN GAGE HEIGHT= 24.00
                        GAGE        MO DAY YEAR  TIME  NREFE  GAGE DEPH.  CODE

BEGIN OF TAPE LABEL= AD37-38         4  3  1970  1430    0        24.00    1000

FIRST RECORD ON MAG.= AD37-38        4  3  1970  1430    0        24.03    1000

                     AD37-38         4  3  1970  15 0    0        24.03    1000
                     AD37-38         4  3  1970  1530    0        24.03    1000
                     AD37-38         4  3  1970  16 0    0        24.03    1000
                     AD37-38         4  3  1970  1630    0        24.03    1000
                     AD37-38         4  3  1970  17 0    0        24.03    1000
                     AD37-38         4  3  1970  1730    0        24.03    1000
                     AD37-38         4  3  1970  18 0    0        24.02    1000
                     AD37-38         4  3  1970  1830    0        24.01    1000
                     AD37-38         4  3  1970  19 0    0        23.98    1000
                     AD37-38         4  3  1970  1930    0        23.97    1000
                     AD37-38         4  3  1970  20 0    0        23.96    1000
                     AD37-38         4  3  1970  2030    0        23.93    1000
                     AD37-38         4  3  1970  21 0    0        23.92    1000
                     AD37-38         4  3  1970  2130    0        23.91    1000
                     AD37-38         4  3  1970  22 0    0        23.90    1000
                     AD37-38         4  3  1970  2230    0        23.88    1000
                     AD37-38         4  3  1970  23 0    0        23.88    1000
                     AD37-38         4  3  1970  2330    0        23.88    1000
                     AD37-38         4  3  1970  24 0    0        23.88    1000
                     AD37-38         4  4  1970   030    0        23.88    1000
                     AD37-38         4  4  1970  1 0     0        23.88    1000
                     AD37-38         4  4  1970   130    0        23.88    1000
                     AD37-38         4  4  1970  2 0     0        23.88    1000
                     AD37-38         4  4  1970   230    0        23.88    1000
                     AD37-38         4  4  1970  3 0     0        23.88    1000
                     AD37-38         4  4  1970   330    0        23.88    1000
                     AD37-38         4  4  1970  4 0     0        23.88    1000
                     AD37-38         4  4  1970   430    0        23.88    1000
                     AD37-38         4  4  1970  5 0     0        23.88    1000
                     AD37-38         4  4  1970   530    0        23.88    1000
                     AD37-38         4  4  1970  6 0     0        23.88    1000
                     AD37-38         4  4  1970   630    0        23.87    1000
                     AD37-38         4  4  1970  7 0     0        23.86    1000
                     AD37-38         4  4  1970   730    0        23.84    1000
LAST RECORD ON MAG.= AD37-38         4  4  1970  8 0     0        23.81    1000

                    ENDING GAGE HEIGHT LABEL=   23.81

                    ENDING ON TAPE LABEL= 4- 4-1970      8 0        23.81
                    END OF TAPE COMPUTED= 4- 4-1970      8 0        23.81
                    ERROR CODE FOR PAPER TAPE-1000
                       35-RECORDS WRITTEN FOR PAPER TAPE
                    RECORDS WERE WRITTEN ON MAG. TAPE-DUMMY
                    A TOTAL OF -   67RECORDS WERE WRITTEN ON MAG. AT THIS POINT
          ERROR CODE=(1000) GOOD DATA TAPE-NO APPARENT ERRORS
```

Figure 14.—An example of printer output from one ground water (aquifer) paper tape record.

magnetic storage tape. The same type, identical first letter, and variable names must be used when reading a record as were used when the record was written on the magnetic tape. The output variables and storage requirements of each of the three types of hydrologic records are described in the following record layouts:

1. Precipitation data storage records: Record Length = 60 bytes (56 actual + 4 extra).

| Variable | IWID | GAGE | NDATE(1) | NDATE(1) | NY11 |
|---|---|---|---|---|---|
| Storage (Bytes) | 4 | 12 | 4 | 4 | 4 |
| Significant Characters per Field | 4 | 12 | 2 | 2 | 2 |

| NDATE(3) | NDATE(4) | NDATE(5) | TRACE | DREC. |
|---|---|---|---|---|
| 4 | 4 | 4 | 4 | 4 |
| 2 | 2 | 2 | 1 | 5 |

| STYPE | NCOD |
|---|---|
| 4 | 4 |
| 1 | 4 |

2. Streamflow Data Storage Records: Record Length = 60 bytes (56 + 4).

| Variable | IWID | GAGE | NDATE(1) | NDATE(2) | NY11 | NDATE(3) |
|---|---|---|---|---|---|---|
| Storage (Bytes) | 4 | 12 | 4 | 4 | 4 | 4 |
| Significant Characters per Field | 4 | 12 | 2 | 2 | 2 | 2 |

| NDATE(4) | NDATE(5) | NTINT | NDST | AREC | NCOD |
|---|---|---|---|---|---|
| 4 | 4 | 4 | 4 | 4 | 4 |
| 2 | 2 | 3 | 1 | 6 | 4 |

3. Ground water well data storage records: Record Length = 60 (56 + 4).

| Variable | IWID | GAGE | NDATE(1) | NDATE(2) | NY11 | NDATE(3) |
|---|---|---|---|---|---|---|
| Storage (Bytes) | 4 | 12 | 4 | 4 | 4 | 4 |
| Significant Characters per Field | 4 | 12 | 2 | 2 | 2 | 2 |

| NDATE(4) | NDATE(5) | NREFE | AAREC | NCOD | BLANK |
|---|---|---|---|---|---|
| 4 | 4 | 4 | 4 | 4 | 4 |
| 2 | 2 | 1 | 8 | 4 | 0 |

| Variables | Description |
|---|---|
| IWID | Watershed Identification number. |
| GAGE | Gage location number. Example: (WE38U----------). |
| NDATE(1) | Month. Example: (12). |
| NDATE(2) | Day. Example: (31). |
| NY11 | First two digits of the year. Example: (19). |
| NDATE(3) | Last two digits of the year. Example: (72). |
| NDATE(4) | Hour (military time). Example: (24). |
| NDATE(5) | Minutes (multiple of 5 or 30). Example: (00). |
| TRACE | Trace on or off for record of precipitation. Example: (T). |
| STYPE | The type of precipitation, a blank represents rainfall. Example: (S). |
| NTINT | Number of 5-minute intervals streamflow gage level in effect. Example: (101). |
| NDST | If equal to zero or blank, a large or single streamflow control. If equal to one, a small control of a dual-control gage. Example: (0). |
| NREFE | If equal to one, the ground water well levels represent elevation. If equal to zero or blank, ground water well levels are actual gage height. Example: (1). |
| DREC | Precipitation amount collected per time interval. Example: (000.2). |
| AREC | Streamflow level for time. Example: (000.25). |
| AAREC | Ground water well level for time. Example: (01985.28). |
| NCOD | Gage malfunction ERROR code. Example: (1,000). |
| BLANK | Used as record-padding space (four blanks). |

## CONCLUSION

The edited magnetic-tape storage data provide the first step to digital hydrologic data analysis. The data from these storage tapes are retained in the original form as basic data master files. Analysis and data correction, aided through use of the malfunction error codes, can be accomplished from the master files at the discretion of the user.

APPENDIX I. GAGE MALFUNCTION ERROR CODES

A ONE IN COLUMN ONE MEANS VALUE PUNCHED ON LAST PUNCH OUT OF PAPER TAPE IS TRUE VALUE RECORDED BY GAGE. A ZER O IN COLUMN ONE MEANS AN ERROR IN LAST VALUE PUNCHED. A 'X' NOTES A CHOICE OF A '1' OR A '0' IN COLUMN ONE.

1000=GOOD DATA TAPE NO APPARENT ERRORS
2000=DATA CONTAINS ESTIMATED VALUES OR (ESTIMATED DATA)

( TIME LOSS CODES )

X010 = TIME LOSS-TIMER FAILURE GAGE STOPPED
X011 = TIME LOSS-LEAF SWITCH FAILURE GAGE RAN CONTINUOUSLY U NTIL BATTERY FAILED
X012 = TIME LOSS-TIMER FAILURE INTERMITTANT OPERATION
X013 = TIME LOSS-TIMER FAILURE TIME DIFFERENCE AT END OF PAP ER TAPE.
X014 = TIME LOSS-
X015 = TIME LOSS-
X016 = TIME LOSS-
X017 = TIME LOSS-
X018 = TIME LOSS-
X019 = TIME LOSS-
X020 = TIME LOSS-NO APPARENT REASON
X021 = TIME LOSS-
X022 = TIME LOSS-LEAF SWITCH FAILURE
X023 = TIME LOSS-BATTERY FAILURE
X024 = TIME LOSS-IMPROPER TAPE INDEXING
X025 = TIME LOSS-PUNCH MOTOR OPERATES INTERMITTANTLY
X026 = TIME LOSS-PUNCH MOTOR FAILURE
X027 = TIME LOSS-
X028 = TIME LOSS-
X029 = TIME LOSS-

( TIME GAIN CODES )

X030 = TIME GAIN-TIMER FAILURE 2 1/2 MINUTE PUNCH INTERVAL
X031 = TIME GAIN-TIMER FAILURE INTERMITTANT OPERATION
X032 = TIME GAIN-LEAF SWITCH FAILURE GAGE RAN CONTINUOUSLY U NTIL BATTERY FAILED
X033 = TIME GAIN-NO APPARENT REASON
X034 = TIME GAIN-LEAF SWITCH FAILURE
X035 = TIME GAIN-IMPROPER TAPE INDEXING
X036 = TIME GAIN-TIMER FAILED TIME DIFFERENCE AT END OF TAPE
X037 = TIME GAIN-
X038 = TIME GAIN-

X039 = TIME GAIN-
X040 = TIME GAIN-
X041 = TIME GAIN-
X042 = TIME GAIN-
X043 = TIME GAIN-
X044 = TIME GAIN-
X045 = TIME GAIN-
X046 = TIME GAIN-
X047 = TIME GAIN-
X048 = TIME GAIN-
X049 = TIME GAIN-

( INCOMPLETE RECORD, IMPROPER PUNCHING, SENSITIVITY CODES)

X050 = TAPE IMPROPERLY INDEXED ( NO TIME LOSS OR GAIN )
X051 = GAGE INSENSITIVE AT SOME POINT ON RECORD
X052 = SNOW WITH FUNNEL IN PLACE
X053 = INTAKE SILT PROBLEM
X054 = INTAKE PIPE STOPPED UP
X055 = DRIFTING SNOW
X056 = FOREIGN MATTER IN COLLECTOR
X057 = CABLE BREAKAGE
X058 = GAGE TAMPERED WITH
X059 = FUNNEL FALLEN IN COLLECTOR
X060 = PRECIPITATION LOSS NO REASON
X061 =
X062 =
X063 =
X064 =
X065 =
X066 =
X067 = PAPER TAPE SUPPLY RAN OUT
X068 = TIMER TURNED TO TEST POSITION
X069 =
X070 = NOTCH OF WEIR PROBLEM (ICE)
X071 = LOG JAMS OR BEBRE IN NOTCH
X072 = VALUE GREATER THAN RANGE OF INSTRUMENT AT SOME POINT
X073 = FLOAT TAPE DISENGAGED FROM RECORDER
X074 =
X075 =
X076 =
X077 =
X078 = ICE JAMMING ( CAUSE HIGH G H )
X079 = HEAVY ICED CREEK

( TRACE INDICATOR MALFUNCTIONS )

NOTE IF TRACE CODE USED OR COMBINATION OF TRACE CODE USED PL
ACE A 1 IN COLUMN 55 OF PAPER TAPE IDENTIFICATION FORM
X080 = TRACE PUNCHES WITHOUT PRECIPITATION
X081 = PRECIPITATION WITHOUT TRACE PUNCHES

X082 = TRACE INCONSISTENT
X083 =
X084 =
X085 =
X086 =
X087 =
X088 =
X089 =

( TRANSLATOR READING ERRORS )

X090 = TRANSLATOR READ HEAD MALFUNCTION ( INCORRECT RECORD )
X091 = MANUALLY INSERTED READING ON DOUBLE PUNCHES WRONG
X092 =
X093 =
X094 =
X095 =
X096 =
X097 =
X098 =
X099 =

( COMPLEX ERROR CODES )

X100 = X024+X026 TIME LOSS IMPROPER INDEXING & PUNCH MOTOR F AILURE
X101 = X035+X026 TIME GAIN IMPROPER INDEXING & MOTOR FAILURE
X102 = X026+X080 MOTOR FAILURE & TRACE WITHOUT PRECIPITATION
X103 = X020+X082 TIME LOSS NO REASON & TRACE INCONSISTANT
X104 = X033+X082 TIME GAIN NO REASON & TRACE INCONSISTANT
X105 = X023+X024 BATTERY FAILED & TIME LOSS TAPE INDEXING
X106 = X023+X035 BATTERY FAILED & TIME GAIN TAPE INDEXING
X107 = X050+X082 TAPE IMPROPER INDEXED & TRACE INCONSISTANT
X108 = X020+X080 TIME LOSS NO APPARENT REASON & TRACE WITHOU T PRECIPITATION
X109 = X033+X080 TIME GAIN NO APPARENT REASON & TRACE WITHOU T PRECIPITATION
X110 = X023+X026 BATTERY FAILURE & PUNCH MOTOR FAILURE
X111 = X024+X081 TIME LOSS IMPROPER INDEXING & PRECIPITATION WITHOUT TRACE
X112 = X035+X081 TIME GAIN IMPROPER INDEXING & PRECIPITATION WITHOUT TRACE
X113 = X024+X082 TIME LOSS IMPROPER INDEXING & TRACE INCONSI STANT.
X114 = X035+X082 TIME GAIN IMPROPER INDEXING & TRACE INCONSI STANT.
X115 = X012+X051 TIME LOSS TIMER INTERMITTANT & GAGE INSENSI TIVE AT A POINT
X116 = X031+X051 TIME GAIN TIMER INTERMITTANT & GAGE INSENSI TIVE AT A POINT
X117 = X070+X054 NOTCH OF WEIR ICE & INTAKE PIPE STOPPED UP
X118 = X060+X050 PRECIPITATION LOSS NO REASON & TAPE IMPROPE

R INDEXING.
X119 = X013+X052+X055 TIME LOSS TIMER FAILURE & SNOW WITH FU
NNEL & DRIFTING SNOW
X120 = X036+X052+X055 TIME GAIN TIMER FAILURE & SNOW WITH FU
NNEL & DRIFTING SNOW
X121 = X024+X052 TIME LOSS IMPROPER TAPE INDEXING & SNOW WIT
H FUNNEL IN PLACE.
X122 = X035+X052 TIME GAIN IMPROPER TAPE INDEXING & SNOW WIT
H FUNNEL IN PLACE.
X123 = X024+X057 TIME LOSS IMPROPER TAPE INDEXING & CABLE BR
EAKAGE
X124 = X035+X057 TIME GAIN IMPROPER TAPE INDEXING & CABLE BR
EAKAGE
X125 = X052+X055 SNOW WITH FUNNEL & DRIFTING SNOW
X126 = X026+X052 PUNCH MOTOR FAILURE & SNOW WITH FUNNEL IN
X127 = X013+X080 TIME LOSS TIMER FAILURE & TRACE WITHOUT PRE
CIPITATION.
X128 = X036+X080 TIME GAIN TIMER FAILURE & TRACE WITHOUT PRE
CIPITATION.
X129 = X026+X030 PUNCH MOTOR FAILURE & TIMER FAILED 2 1/2 MI
NUTE PUNCH OUT
X130 = X081+X050 PRECIPITATION WITHOUT TRACE & TAPE IMPROPER
LY INDEXED
X131 = X091+X024 TRANSLATOR READ HEAD MALFUNCTION & TIME LOS
S TAPE INDEXING.
X132 = X091+X035 TRANSLATOR READ HEAD MALFUNCTION & TIME GAI
N TAPE INDEXING.
X133 = X072+X073 VALUE GREATER THAN RANGE & FLOAT TAPE DISEN
GAGED.
X134 = X033+X081 TIME GAIN NO APPARENT REASON AND PRECIP. WI
THOUT TRACE.
X135 =
X136 =
X137 =
X138 =
X139 =
X140 =
X141 =
X142 =
X143 =
X144 =
X145 =
X146 =
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X189 =
X190 =
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X193 =
X194 =
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X198 =
X199 =

APPENDIX II. COMPUTER SOURCE PROGRAM LISTING.

```
      LOGICAL*1 WSH(16),HCARD1(54),HCARD2(54),HCARD3(54)
      LOGICAL*1 OUT2(6),ACARD(80)
      COMMON OUT2,ACARD
      COMMON/BLK1/STYPE(999),AREC(257),CREC(257),ATRA(257),C
     1TRA(257),    GAGE(3),GAG(3),NSDTE(999,3),NDATE(257,5)
      COMMON/BLK2/J,I,L,NSTOP,NCHECK,NSTORE,ISTORE,ICHECK,NI
     1CE,          NWSH,KSEQ,NSEQ,NOTE,MIAC,NSKIP,NLIST,NPFG,
     2NOPT,NCPT,NTPT,NTYPE,NX,KB,IX,MAXNO,IEOF,NOEOF,NCOD,IT
     3,KT,NSTART,LDATA,ELEREF,NSC,YACC,ACC,NTRACE,ABASE,NSNO
     4W,INDEX,NGO,NEED,NUT,ATREC,BTREC,ITIC          ,NOST,
     5NTINT,LTINT,NORM,LHEC,DREC,NTIC,ADIFF,NFIRST,NREFE,NPI
     6L
      COMMON/BLK3/NH1,NY22,NMIN,IYR,MT1,NM1,NY2,NMONTH,IHR,N
     1D1,ARD1,NH2,NDAY,IMO,IMN,NY11,MT2,NM2,NYEAR,IDA,NY1,ND
     22,ARD2,NHOUR,NYE,NYXX,  ITMO,ITDA,ITYR,ITHR,ITMN,GREF,
     3MASH,NDEX,KTMO,KTDA,KTY,KTYR,KTHR,  KTMN,NSTARE,IY,ARE
     4D,MTINT,IWID
      COMMON/BLK4/LLL(12)/BLK5/TR(2)
      CALL ERRSET (215,256,-1,1,1)
      NFILE=1
      NCPT=0
      NSEQQ=0
 5001 KSEQ=0
C INTIALIZING OF STORAGE
      DO 1 L=1,257
      DO 1 I=1,5
      ATRA(L)=0.0
      AREC(L)=00.00
      CTRA(L)=0.0
      CREC(L)=00.00
    1 NDATE(L,I)=00
      DO 55 I=1,999
      DO 55 K=1,3
   55 NSDTE(I,K)=00
      NSTORE=0
      NOTE=0
      NSTOP=0
      NSEQ=0
      NSNOW=0
      ATREC=0.0
      BTREC=0.0
      KB=0
      NREFE=0
      NORM=0
```

```
C  READ HEADER CARD FOR NUMBER OF PAGE HEADING CARDS
      READ(5,152) NHEAD,NSC
  152 FORMAT(I1,I3)
C  READ PAGE HEADING CARDS
      IF(NHEAD.EQ.0) GO TO 5002
      READ(5,5003) HCARD1
 5003 FORMAT(54A1)
      IF(NHEAD.EQ.1) GO TO 5002
      READ(5,5003) HCARD2
      IF(NHEAD.EQ.2) GO TO 5002
      READ(5,5003) HCARD3
 5002 CONTINUE
C X X X X  SNOW CARDS READ IF NSC GT ZERO AND PRECIP DATA
      IF(NSC.EQ.0) GO TO 3
      DO 151 I=1,NSC
      READ(5,2)(NSDTE(I,L),L=1,3),STYPE(I)
    2 FORMAT(3I2,A1)
  151 CONTINUE
    3 NOPT=0
      NCHECK=0
      INDEX=1
      YACC=0.0
      NEED=0
      IX=0
      NSTART=0
      IF(NSC.EQ.0) NSC=1
C X X X X CONTROL CARD READ
      READ(5,4)STATE,IWID,WSH,GAG ,NPFG,NTPT,IEOF,IT,KT,OUT2
     1,NSKIP,NOEOF,KT1,KT2,KT3,KT4,NDST,NEWDAT,IGREF
    4 FORMAT(A3,I4,16A1, 3A4,2I2,I1,2I2,6A1,I1,5I2,2I1,I4)
C X X X X X X X X X LABEL CARD READ X X X X X X X X
    5 READ(5,6) NCOD,GAGE,NPIL,NTYPE,NTRACE,MT1,ND1,NY11,NY1
     1,NH1,NM1,ARD1,MT2,ND2,NY22,NY2,NH2,NM2,ARD2,ICHECK,NLI
     2ST,ITCHG,LDATA,ELEREF
    6 FORMAT(I4, 3A4,I2,2I1,2(6I2,F4.2),4I1,F6.2)
      AGREF=IGREF
      IF(NTYPE.EQ.1) GREF=AGREF*.1
      IF(NTYPE.EQ.2.OR.NTYPE.EQ.3) GREF=AGREF*.01
      IF(IGREF.EQ.0.AND.NTYPE.EQ.1) GREF=001.0
      IF(IGREF.EQ.0.AND.NTYPE.EQ.2) GREF=30.00
      IF(IGREF.EQ.0.AND.NTYPE.EQ.3) GREF=60.00
      IF(IGREF.EQ.0.AND.NTYPE.EQ.3.AND.ELEREF.GT.0.0) GREF=E
     1LEREF+60.00
      MIAC=1
      IF(ITCHG.EQ.1) NTRACE=0
C X X X X X X  CHECKING FOR PROPER DATA TYPE AND WRITING HEA
C     DINGS
      DO 992 MN=1,3
      IF(GAGE(MN).EQ.GAG(MN)) GO TO 992
      GO TO 991
```

```
  992  CONTINUE
       GO TO 8
  991  WRITE(6,7)
     7 FORMAT(' STOPPED WRONG TYPE DATA OR GAGE NAMES DO NOT
      1MATCH')
       GO TO 3000
  8    WRITE(6,5004)
  5004 FORMAT(1H1)
       IF(NHEAD.EQ.0) GO TO 5006
       WRITE(6,5005)HCARD1
  5005 FORMAT(37X,54A1)
       IF(NHEAD.EQ.1) GO TO 5006
       WRITE(6,5005)HCARD2
       IF(NHEAD.EQ.2) GO TO 5006
       WRITE(6,5005)HCARD3
  5006 WRITE(6,9) STATE,IWID,WSH,GAGE
  9    FORMAT(37X,'STATE-',A3,5X,'STATE IND. NO.=',I4//37X,
      1'WATERSHED=',16A1,5X,'GAGE=', 3A4//)
       NICE=0
       NOTE=0
       NWSH=0
       NYE=NY11
       NMONTH=MT1
       NDAY=ND1
       NYEAR=NY1
       NHOUR=NH1
       NMIN=NM1
       NX=0
       IMO=MT2
       IDA=ND2
       IY=NY22
       IYR=NY2
       IHR=NH2
       IMN=NM2
       ARED=ARD2
       NUT=0
       ACC=0.0
       NSTARE=0
       ISTORE=0
       ITIC=0
       NEED=0
       NGO=0
       NFIRST=1
       IF(ICHECK.EQ.0) GO TO 14
C X X X X X X X X READ TRANSLATOR ERROR CARD
       READ(5,31) IMO,IDA,IY,IYR,IHR,IMN,ARED
  31   FORMAT(36X,6I2,F4.2)
  14   IF(NSTORE.EQ.0) GO TO 15
C X X X X X X X X TAKE OUT OF STORAGE DATA STORED FROM LAS
C      T READ
```

```
      DO 101 J=1,MAXNO
      AREC(J)=CREC(KB)
      IF(NTYPE.NE.1) GO TO 101
      ATRA(J)=CTRA(KB)
  101 KB=KB+1
      J=MAXNO
      GO TO 103
C X X X X X X X X X INPUT DATA READ OF MAG. TAPE
C X X X X X X X X X TEST FOR FOUR NINES END OF TAPE
   15 DO 150 J=1,255
      IF(NTYPE.EQ.1) GO TO 9002
      READ(IT,10,END=200,ERR=9000) AREC(J)
   10 FORMAT(F4.2)
      IF(IEOF.EQ.1) GO TO 150
 9001 IF(AREC(J).EQ.99.99) GO TO 104
      GO TO 150
 9000 READ(IT,10,END=200,ERR=9001) AREC(J)
      IF(IEOF.EQ.1) GO TO 150
      GO TO 9001
 9002 READ(IT,99,END=200,ERR=9003) ATRA(J),AREC(J)
   99 FORMAT(F1.0,F3.1)
      IF(IEOF.EQ.1) GO TO 150
 9004 IF(AREC(J).EQ.99.9.AND.ATRA(J).EQ.9.) GO TO 104
      GO TO 150
 9003 READ(IT,99,END=200,ERR=9004) ATRA(J),AREC(J)
      IF(IEOF.EQ.1) GO TO 150
      GO TO 9004
  150 CONTINUE
C X X X X X X X X X CONTINUE NOT END OF PAPER TAPE
      J=255
  103 NSTORE=0
      NCHECK=0
      NOTE=0
   13 CALL DATIME
      GO TO 11
C X X X X X X X X X END OF PAPER TAPE STEP PAPER TAPE COUNTE
C     R
  104 NCPT=NCPT+1
      NOPT=NOPT+1
      NOTE=1
      NSTORE=0
      NCHECK=1
      NX=1
      IF(J.EQ.1) GO TO 110
      NX=0
      J=J-1
      CALL DATIME
   11 IF(NORM.EQ.1) GO TO 12
      GO TO 110
   12 CALL CHECKO
```

```
      IF(NSTOP.EQ.1) GO TO 3000
      GO TO 110
C X X X X X X X X X READ END OF FILE BRANCH ON DATA READ
  200 NCPT=NCPT+1
      NOPT=NOPT+1
      NSTOP=0
      NSTORE=0
      NCHECK=1
      NOTE=1
      IF(J.EQ.1) GO TO 13
      J=J-1
      GO TO 13
C X X X X X X X X X TEST TO SEE IF END OF ALL PAPER TAPES FO
C     R A GAGE,OR
C X X X X X X X X X END OF ALL PAPER TAPES FOR THE RUN
  110 IF(NOPT.EQ.NPFG) NWSH=1
      IF(NCPT.EQ.NTPT) NSTOP=1
      LTINT=0
      IF(NX.EQ.1) GO TO 311
      NX=0
      IF(NTYPE.LT.1.OR.NTYPE.GT.3) GO TO 991
      IF(NTYPE.EQ.1) CALL PRECIP
      IF(NTYPE.EQ.2) CALL RUNOFF
      IF(NTYPE.EQ.3) CALL AQUFER
  311 NSTARE=1
      NICE=1
      IF(NCHECK.EQ.1) NSTARE=0
      IF(NCHECK.EQ.1) GO TO 28
      GO TO 15
   28 CALL OUTPUT
      IF(NSTOP.EQ.1) GO TO 32
      IF(NWSH.EQ.1.AND.NEWDAT.EQ.1) GO TO 32
      IF(NWSH.EQ.1) GO TO 3
      GO TO 5
C X X X X X X X X X END OF PROGRAM WRITE INFRC ABOUT TAPE SE
C     PERATERS
   32 NSEQQ=NSEQQ+NSEQ
      IF(IEOF.EQ.0) GO TO 51
      WRITE(6,50)
   50 FORMAT(' INPUT PAPER TAPES WHERE SEPERATED BY EOFS')
      GO TO 500
   51 WRITE(6,53)
   53 FORMAT(' INPUT PAPER TAPES WHERE SEPERATED BY FOUR-NIN
     1ES')
  500 IF(NEWDAT.EQ.0) GO TO 501
      WRITE(6,452) NSEQ,NFILE
  452 FORMAT(1H0,'TOTAL RECORDS WRITTEN ON MAG. TAPE=',I6,'
     1FOR TAPE FILE NO.',I3)
      IF(NSKIP.EQ.1) GO TO 5001
      NFILE=NFILE+1
```

```
      END FILE KT
      GO TO 5001
  501 WRITE(6,451)NSEQQ
  451 FORMAT(1HO,'TOTAL NO. RECORDS WRITTEN ON MAG. TAPE=',I
     16)
      IF(KT1.NE.0) END FILE KT1
      IF(KT2.NE.0) END FILE KT2
      IF(KT3.NE.0) END FILE KT3
      IF(KT4.NE.0) END FILE KT4
 3000 STOP
      END
      SUBROUTINE DATIME
C     SUBR. COMPUTES DATE AND TIME FOR EACH RECORD READ IN
      LOGICAL*1 OUT2(6),ACARD(80)
      COMMON OUT2,ACARD
      COMMON/BLK1/STYPE(999),AREC(257),CREC(257),ATRA(257),C
     1TRA(257),   GAGE(3),GAG(3),NSDTE(999,3),NDATE(257,5)
      COMMON/BLK2/J,I,L,NSTOP,NCHECK,NSTORE,ISTORE,ICHECK,NI
     1CE,          NWSH,KSEQ,NSEQ,NOTE,MIAC,NSKIP,NLIST,NPFG,
     2NOPT,NCPT,NTPT,NTYPE,NX,KB,IX,MAXNO,IEOF,NOEOF,NCOD,IT
     3,KT,NSTART,LDATA,ELEREF,NSC,YACC,ACC,NTRACE,ABASE,NSNO
     4W,INDEX,NGO,NEED,NUT,ATREC,BTREC,ITIC          ,NDST,
     5NTINT,LTINT,NORM,LHEC,DREC,NTIC,ADIFF,NFIRST,NREFE,NPI
     6L
      COMMON/BLK3/NH1,NY22,NMIN,IYR,MT1,NM1,NY2,NMONTH,IHR,N
     1D1,ARD1,NH2,NDAY,IMO,IMN,NY11,MT2,NM2,NYEAR,IDA,NY1,ND
     22,ARD2,NHOUR,NYE,NYXX,  ITMO,ITDA,ITYR,ITHR,ITMN,GREF,
     3MASH,NDEX,KTMO,KTDA,KTY,KTYR,KTHR,  KTMN,NSTARE,IY,ARE
     40,MTINT,IWID
      COMMON/BLK4/LLL(12)/BLK5/TR(2)
C X X X X X X  LEAP YEAR TEST X X X X X X X X X XX
      LLL(2)=28
      IF(NYEAR.EQ.00.AND.NYE.NE.20) GO TO 11
      IF(NYEAR.EQ.00.AND.NYE.NE.20) GO TO 11
      IF((NYEAR/4*4).EQ.NYEAR) LLL(2)=29
C X X X X X X X X X FILLING ARRAY WITH DATE TIME OF EACH GAG
C     E HEIGHT
   11 IF(J.EQ.256) J=J-1
      DO 13 I=1,J
      NDATE(I,1)=NMONTH
      NDATE(I,2)=NDAY
      NDATE(I,3)=NYEAR
      NDATE(I,4)=NHOUR
      NDATE(I,5)=NMIN
      IF(NCOD.NE.1000.AND.ICHECK.EQ.0) GO TO 446
      IF((IMO.EQ.NMONTH).AND.(IDA.EQ.NDAY).AND.(IYR.EQ.NYEAR
     1).AND.(IHR.EQ.NHOUR).AND.(IMN.EQ.NMIN)) GO TO 107
  446 IF((NMONTH.EQ.12).AND.(NDAY.EQ.31).AND.(NHOUR.EQ.24))
     1GO TO 12
      NMIN=NMIN+NPIL
```

```
      MIAC=MIAC+1
      IF(NMIN.NE.60) GO TO 34
      NHOUR=NHOUR+01
      NMIN=00
34    IF((NHOUR.EQ.24).AND.(NMIN.EQ.00)) GO TO 13
      IF(NHOUR.LT.24) GO TO 13
      NDAY=NDAY+01
      NHOUR=00
      K=NMONTH
      IF(NDAY.LE.LLL(K)) GO TO 13
      NMONTH=NMONTH+01
      NDAY=01
      GO TO 13
12    NMONTH=01
      NDAY=01
      NYEAR=NYEAR+01
      LLL(2)=28
      IF(NYEAR.EQ.00.AND.NYE.NE.20) GO TO 1001
      IF((NYEAR/4*4).EQ.NYEAR) LLL(2)=29
1001  IF(NYEAR.NE.100) GO TO 20
      NYEAR=00
      NY11=NY11+1
      NY22=NY22+1
20    NHOUR=00
      NMIN=NPIL
13    CONTINUE
      NORM=0
      GO TO 108
107   NORM=1
108   RETURN
      END
      SUBROUTINE CHECKO
C   SUBR. FINDS END OF PAPER TAPE IF ICHECK CODE IS USED AND
C       A ERROR HAS OCURRED
      LOGICAL*1 OUT2(6),ACARD(80)
      COMMON OUT2,ACARD
      COMMON/BLK1/STYPE(999),AREC(257),CREC(257),ATRA(257),C
     1TRA(257),    GAGE(3),GAG(3),NSDTE(999,3),NDATE(257,5)
      COMMON/BLK2/J,I,L,NSTOP,NCHECK,NSTORE,ISTORE,ICHECK,NI
     1CE,          NWSH,KSEQ,NSEQ,NOTE,MIAC,NSKIP,NLIST,NPFG,
     2NOPT,NCPT,NTPT,NTYPE,NX,KB,IX,MAXNO,IEOF,NOEOF,NCOD,IT
     3,KT,NSTART,LDATA,ELEREF,NSC,YACC,ACC,NTRACE,ABASE,NSNO
     4W,INDEX,NGO,NEED,NUT,ATREC,BTREC,ITIC          ,NDST,
     5NTINT,LTINT,NORM,LHEC,DREC,NTIC,ADIFF,NFIRST,NREFE,NPI
     6L
      COMMON/BLK3/NH1,NY22,NMIN,IYR,MT1,NM1,NY2,NMONTH,IHR,N
     1D1,ARD1,NH2,NDAY,IMO,IMN,NY11,MT2,NM2,NYEAR,IDA,NY1,ND
     22,ARD2,NHOUR,NYE,NYXX,  ITMO,ITDA,ITYR,ITHR,ITMN,GREF,
     3MASH,NDEX,KTMO,KTDA,KTY,KTYR,KTHR,  KTMN,NSTARE,IY,ARE
     4D,MTINT,IWID
```

```
      COMMON/BLK4/LLL(12)/BLK5/TR(2)
C * * * CHECK TO SEE IF PAPER TAPE SEPERATORS EOFS OR 4 NINE
C     S
      NPEXT=0
      IF(IEOF.EQ.1) GO TO 205
C X X X X X X X X X TESTING TO SEE IF END OF PAPER TAPE CONT
C     ROL FOUR
C X X X X X X X X X -NINES WAS LEFT OUT OR DIFFERENT(SEE ICH
C     ECK)
  107 IF(NOTE.EQ.0) GO TO 100
C  FOUND 4 NINES
  108 IF(ICHECK.EQ.2) GO TO 116
      IF(ICHECK.GT.5) GO TO 125
  118 J=I
      NSTORE=0
      GO TO 110
  116 IF(NTYPE.EQ.1) GO TO 9004
      READ(IT,10,END=201,ERR=9001) EREC
   10 FORMAT(F4.2)
  120 IF(IEOF.EQ.1) GO TO 109
      IF(EREC.EQ.99.99) GO TO 118
C X X X X X X X X X STORE DATA FOR NEXT PAPER TAPE
  109 NSTORE=1
      IF(NTYPE.EQ.1) CTRA(1)=ETRA
      CREC(1)=EREC
      MAXNO=1
      J=I
      KB=1
      GO TO 110
 9004 READ(IT,99,END=201,ERR=9005) ETRA,EREC
   99 FORMAT(F1.0,F3.1)
 9006 IF(IEOF.EQ.1) GO TO 109
      IF(EREC.EQ.99.9.AND.ETRA.EQ.9.) GO TO 118
      GO TO 109
 9005 READ(IT,99,END=201,ERR=9004) ETRA,EREC
      GO TO 9006
 9001 READ(IT,10,END=201,ERR=116 ) EREC
      GO TO 120
  100 NCPT=NCPT+1
      NOPT=NOPT+1
      NCHECK=1
      IF(NPEXT.EQ.1) GO TO 108
      NEDR=0
      I2=J-I
      J=I
      IF(I2.EQ.0) NEDR=1
      IF(NEDR.EQ.1) I2=255
      I1=I+1
      IF(NEDR.EQ.1) I1=1
      KEND=I1+(I2-1)
```

```
      NKK=0
      NCC=0
      IKK=0
      IF(NEDR.EQ.0) GO TO 170
      GO TO 190
  170 DO 171 KP=I1,KEND
      IF(NTYPE.EQ.1) CTRA(KP)=ATRA(KP)
  171 CREC(KP)=AREC(KP)
C     NEED TO READ TAPE INTO MREC ARRAY IF(NEDR=1) GO TO 190
  179 DO 180 KX=I1,KEND
      IF(IEOF.EQ.1) GO TO 111
      IF(NTYPE.EQ.1) GO TO 9007
      IF(CREC(KX).EQ.99.99) GO TO 182
 9008 IF(CREC(KX).EQ.00.0) GO TO 180
  112 NKK=1
      GO TO 184
  111 IF(EREC.EQ.00.0) GO TO 180
      GO TO 112
 9007 IF(CREC(KX).EQ.99.9.AND.CTRA(KX).EQ.9.) GO TO 182
      GO TO 9008
  180 CONTINUE
      NEDR=1
      IKK=IKK+1
      IF(IKK.EQ.5) GO TO 125
  174 I1=1
      KEND=255
      GO TO 190
  182 IF(ICHECK.EQ.2) GO TO 183
      IF(KX.EQ.KEND) GO TO 199
  188 MAXNO=KEND-KX
      KB=KX+1
  189 NSTORE=1
      GO TO 110
  184 IF(KX.EQ.KEND) GO TO 173
      KV=KX+1
  192 IF(IEOF.EQ.1) GO TO 186
      IF(NTYPE.EQ.1) GO TO 9009
      IF(CREC(KV).EQ.99.99) GO TO 172
  186 IF(KV.EQ.KEND) GO TO 187
      KV=KV+1
      GO TO 192
 9009 IF(CREC(KV).EQ.99.9.AND.CTRA(KV).EQ.9.) GO TO 172
      GO TO 186
  187 MAXNO=KEND-(KX-1)
      KB=KX
      IF(ICHECK.EQ.3) GO TO 188
      GO TO 189
  172 MAXNO=KEND-KV
      KB=KV+1
      GO TO 189
```

```
  173   CREC(1)=CREC(KX)
        IF(NTYPE.EQ.1) CTRA(1)=CTRA(KX)
        I1=2
        KEND=255
  190   DO 191 KX=I1,KEND
        IF(NTYPE.EQ.1) GO TO 9010
        READ(IT,10,END=201,ERR=9002) CREC(KX)
        GO TO 191
 9010   READ(IT,99,END=201,ERR=9011) CTRA(KX),CREC(KX)
        GO TO 191
 9011   READ(IT,99,END=201) CTRA(KX),CREC(KX)
        GO TO 191
 9002   READ(IT,10,END=201) CREC(KX)
  191   CONTINUE
        GO TO 179
  183   NCC=NCC+1
        IF(KX.EQ.KEND) GO TO 174
        IF(NCC.EQ.2) GO TO 188
        I1=KX+1
        GO TO 179
  199   NSTORE=0
        GO TO 110
  125   WRITE(6,126)
  126   FORMAT(' UNABLE TO DETERMINE END OF PAPER TAPE---STOPP
       1ED')
        NSTOP=1
        GO TO 110
C X X X END OF FILES USED AS TAPE SEPERATORS
  205   IF(NOTE.EQ.1) GO TO 108
        IF(ICHECK.EQ.2) GO TO 206
        GO TO 100
  206   DO 207 KXE=1,255
        IF(NTYPE.EQ.1) GO TO 9012
        READ(IT,10,END=203,ERR=9003) CREC(KXE)
        GO TO 207
 9012   READ(IT,99,END=203,ERR=9013) CTRA(KXE),CREC(KXE)
        GO TO 207
 9013   READ(IT,99,END=203) CTRA(KXE),CREC(KXE)
        GO TO 207
 9003   READ(IT,10,END=203) CREC(KXE)
  207   CONTINUE
        MAXNO=255
        KB=1
        NSTORE=1
        J=I
        GO TO 110
C X X X BRANCH ON END OF FILE FROM EOF SEPERATORS
  203   NPEXT=1
        GO TO 100
C X X X X X X X X X READ END OF FILE BRANCH ON ICHECK ROUTI
```

```
C       NE READ)
  201   NSTOP=0
  202   NCHECK=1
        NSTORE=0
        NOTE=1
        GO TO 118
  110   RETURN
        END
        SUBROUTINE PRECIP
        LOGICAL*1 OUT2(6),ACARD(80)
        COMMON OUT2,ACARD
        COMMON/BLK1/STYPE(999),AREC(257),CREC(257),ATRA(257),C
       1TRA(257),    GAGE(3),GAG(3),NSDTE(999,3),NDATE(257,5)
        COMMON/BLK2/J,I,L,NSTOP,NCHECK,NSTORE,ISTORE,ICHECK,NI
       1CE,          NWSH,KSEQ,NSEQ,NOTE,MIAC,NSKIP,NLIST,NPFG,
       2NOPT,NCPT,NTPT,NTYPE,NX,KB,IX,MAXNO,IECF,NOECF,NCOD,IT
       3,KT,NSTART,LDATA,ELEREF,NSC,YACC,ACC,NTRACE,ABASE,NSNO
       4W,INDEX,NGO,NEED,NUT,ATREC,BTREC,ITIC             ,NDST,
       5NTINT,LTINT,NORM,LHEC,DREC,NTIC,ADIFF,NFIRST,NREFE,NPI
       6L
        COMMON/BLK3/NH1,NY22,NMIN,IYR,MT1,NM1,NY2,NMONTH,IHR,N
       1D1,ARD1,NH2,NDAY,IMO,IMN,NY11,MT2,NM2,NYEAR,IDA,NY1,ND
       22,ARD2,NHOUR,NYE,NYXX,  ITMO,ITDA,ITYR,ITHR,ITMN,GREF,
       3MASH,NDEX,KTMO,KTDA,KTY,KTYR,KTHR,  KTMN,NSTARE,IY,ARE
       4D,MTINT,IWID
        COMMON/BLK4/LLL(12)/BLK5/TR(2)
        IF(NICE.EQ.1) GO TO 229
        WRITE(6,201)
  201   FORMAT(26X,'GAGE',7X,'MONTH  DAY   YEAR',4X,
       3'TIME     TRACE   PRECIP DEPTH   TYPE  PRECIP   CODE'/
       126X,' NO.',27X,'HR   MIN          FOR INTERVAL
       2   ACC.'/77X,'(INCHES)           (INCHES)'/)
C X X X X X X X X X WRITE BEGINNING DATE TIME GAGE HEIGHT IF
C       THE FIRST
C X X X X X X X X X READING OF A PAPER TAPE
        BRD1=ARD1*10.0
        WRITE(6,46) MT1,ND1,NY11,NY1,NH1,NM1,BRD1
    46  FORMAT(37X,'PAPER TAPE BEGINNING DATE,TIME,READING=',I
       12,'/',I2,'/',2I2,3X,I2,I2,2X,F4.1/)
C X X X X X X X X X ROUTINE TO EDIT OUT EXTRANEOUS READINGS,
C       WRITE ON MAG
        NTIC=0
        NSNOW=0
        IF(J.EQ.1) GO TO 311
        I=3
        GO TO 306
  229   I=1
  306   IF(NSTARE.EQ.1) GO TO 307
        ABASE=AREC(I)
  307   IF(NTRACE.EQ.1) GO TO 350
```

```
C
C
C X X X X X X X  TRACE OUT ROUTINE
      IF(AREC(I).LE.ABASE) GO TO 313
      KIX=I+1
      NJOE=1
      IF(KIX.EQ.J) GO TO 400
      IF(AREC(KIX).EQ.ABASE) GO TO 401
  400 ADIFF=AREC(I)-ABASE
      IF(ADIFF.GT.GREF) GO TO 313
  310 IF(NSNOW.EQ.1) GO TO 309
      MASH=1
  316 DO 317 INDEX=1,NSC
      IF(NDATE(I,1).EQ.NSDTE(INDEX,1).AND. NDATE(I,2).EQ.NSD
     1TE(INDEX,2).AND.NDATE(I,3).EQ.NSDTE(INDEX,3))GO TO 315
  317 CONTINUE
      NSNOW=0
      GO TO (309,313),MASH
  309 DREC=AREC(I)-ABASE
      ACC=ACC+DREC
      TRACE=TR(1)
      IF(IX.LT.12) GO TO 328
      WRITE(6,329)
  329 FORMAT(1H )
      IF(NSKIP.EQ.1) GO TO 4000
      LX=I-1
      TYPE=TR(1)
      IF(LX.EQ.0) GO TO 392
      KTMO=NDATE(LX,1)
      KTDA=NDATE(LX,2)
      KTYR=NDATE(LX,3)
      KTHR=NDATE(LX,4)
      KTMN=NDATE(LX,5)
      KTX=NY11
  392 AKTC=ACC-DREC
      WRITE(6,27)GAGE,KTMO,KTDA,KTY,KTYR,KTHR,KTMN,TRACE,ATR
     1EC,TYPE,AKTC,NCOD
      WRITE(KT)IWID,GAGE,KTMO,KTDA,KTY,KTYR,KTHR,KTMN,TRACE,
     1ATREC,TYPE, NCOD
      KSEQ=KSEQ+1
      GO TO 328
  328 TYPE=TR(1)
      IF(NSNOW.EQ.1) TYPE=STYPE(NDEX)
      IF(NSKIP.EQ.1) GO TO 4000
      WRITE(6,27) GAGE,(NDATE(I,M),M=1,2),NY11,(NDATE(I,N),N
     1=3,5),TRACE ,DREC,TYPE,ACC,NCOD
   27 FORMAT(23X, 3A4,3X,I2,4X,I2,4X,2I2,3X,I2,3X,I2,5X,A1,7
     1X,F5.1,9X,A1,4X,F5.1,4X,I4)
      WRITE(KT) IWID,GAGE,(NDATE(I,M),M=1,2),NY11,(NDATE(I,N
     1),N=3,5),TRACE,DREC,TYPE,NCOD
```

```
      KSEQ=KSEQ+1
 4000 IF(NDATE(I,4).EQ.24) NSNOW=0
      NEED=1
      NTIC=0
      ITIC=0
      ABASE=AREC(I)
      NGO=0
      IX=0
      NUT=1
      GO TO 312
  401 ABASE=AREC(KIX)
      I=KIX
      IF(NJOE.EQ.2) GO TO 403
      GO TO 313
  315 NSNOW=1
      NOEX=INDEX
      GO TO (309,313),MASH
C
C X X X X X X X JOINING OF TRACE AND NO TRACE ROUTINES
C
  313 IX=IX+1
      IF(NDATE(I,4).EQ.24) NSNOW=0
  312 IF(I.EQ.J) GO TO 311
      I=I+1
      GO TO 307
C
C X X X X X TRACE IN ROUTINE
C
  350 IF(AREC(I).GT.ABASE) GO TO 351
  403 IF(ISTORE.EQ.1) GO TO 352
      IF(ATRA(I).NE.8.0) GO TO 354
  360 ISTORE=1
      ITMO=NDATE(I,1)
      ITDA=NDATE(I,2)
      ITYR=NDATE(I,3)
      ITHR=NDATE(I,4)
      ITMN=NDATE(I,5)
  355 ITIC=1
      IF(NSNOW.EQ.1) GO TO 313
      MASH=2
      GO TO 316
  354 ITIC=0
      IF(NEED.EQ.1) NTIC=NTIC+1
      IF(NTIC.LT.12) GO TO 313
      NEED=0
      NTIC=0
      GO TO 313
  364 KSEQ=KSEQ+1
 4001 ISTORE=0
      ITIC=0
```

```
      NTIC=0
      IX=0
      NUT=1
      IF(NGO.EQ.1) GO TO 310
      GO TO 313
352   IF(NEED.EQ.1) GO TO 365
      IF(ITIC.EQ.12) GO TO 366
      ITIC=ITIC+1
      GO TO 313
365   IF(NTIC.GE.12) GO TO 390
      NTIC=NTIC+1
      GO TO 313
390   NEED=0
      ISTORE=0
      NTIC=0
      ITIC=0
      GO TO 313
366   IF(NSNOW.NE.0) GO TO 367
      IF(ATRA(I).EQ.8.) GO TO 360
      ISTORE=0
      ITIC=0
      GO TO 313
367   IF(NDATE(I,4).NE.24) GO TO 355
      ACC=ACC+ATREC
      IF(NSKIP.EQ.1) GO TO 4001
      WRITE(6,329)
      WRITE(6,27) GAGE,ITMO,ITDA,NY11,ITYR,ITHR,ITMN,TR(2),A
     1TREC,STYPE(NDEX),ACC,NCOD
      WRITE(KT) IWID,GAGE,ITMO,ITDA,NY11,ITYR,ITHR,ITMN,TR(2
     1),BTREC,STYPE(NDEX),NCOD
      NSNOW=0
      GO TO 364
351   KIX=I+1
      NJOE=2
      IF(KIX.EQ.J) GO TO 402
      IF(AREC(KIX).EQ.ABASE) GO TO 401
402   ADIFF=AREC(I)-ABASE
      IF(ADIFF.GT.GREF) GO TO 368
      TRACE=TR(2)
      TYPE=TR(1)
      IF(NSNOW.EQ.1) TYPE=STYPE(NDEX)
      IF(NEED.EQ.1) GO TO 391
      IF(ISTORE.EQ.1) GO TO 370
      ITIC=0
      GO TO 310
370   WRITE(6,329)
      ACC=ACC+ATREC
      IF(NSKIP.EQ.1) GO TO 371
      WRITE(6,27) GAGE,ITMO,ITDA,NY11,ITYR,ITHR,ITMN,TRACE,A
     1TREC,TYPE,  ACC,NCOD
```

```
      WRITE(KT) IWID,GAGE,ITMO,ITDA,NY11,ITYR,ITHR,ITMN,TRAC
     1E,BTREC,TYPE,NCOD
  371 NGO=1
      IF(NSKIP.EQ.1) GO TO 4001
      GO TO 364
  391 NGO=1
      GO TO 4001
  368 IF(ISTORE.EQ.1) GO TO 352
      GO TO 313
  311 KTMO=NDATE(J,1)
      KTDA=NDATE(J,2)
      KTY=NY11
      KTYR=NDATE(J,3)
      KTHR=NDATE(J,4)
      KTMN=NDATE(J,5)
      RETURN
      END
      SUBROUTINE RUNOFF
      LOGICAL*1 OUT2(6),ACARD(80)
      COMMON OUT2,ACARD
      COMMON/BLK1/STYPE(999),AREC(257),CREC(257),ATRA(257),C
     1TRA(257),   GAGE(3),GAG(3),NSDTE(999,3),NDATE(257,5)
      COMMON/BLK2/J,I,L,NSTOP,NCHECK,NSTORE,ISTORE,ICHECK,NI
     1CE,          NWSH,KSEQ,NSEQ,NOTE,MIAC,NSKIP,NLIST,NPFG,
     2NOPT,NCPT,NTPT,NTYPE,NX,KB,IX,MAXNO,IECF,NOECF,NCOD,IT
     3,KT,NSTART,LDATA,ELEREF,NSC,YACC,ACC,NTRACE,ABASE,NSNO
     4W,INDEX,NGO,NEED,NUT,ATREC,BTREC,ITIC          ,NDST,
     5NTINT,LTINT,NORM,LHEC,DREC,NTIC,ADIFF,NFIRST,NREFE,NPI
     6L
      COMMON/BLK3/NH1,NY22,NMIN,IYR,MT1,NM1,NY2,NMONTH,IHR,N
     1D1,ARD1,NH2,NDAY,IMO,IMN,NY11,MT2,NM2,NYEAR,IDA,NY1,ND
     22,ARD2,NHOUR,NYE,NYXX,  ITMO,ITDA,ITYR,ITHR,ITMN,GREF,
     3MASH,NDEX,KTMO,KTDA,KTY,KTYR,KTHR,  KTMN,NSTARE,IY,ARE
     4D,MTINT,IWID
      COMMON/BLK4/LLL(12)/BLK5/TR(2)
      IF(NICE.EQ.1) GO TO 229
      LTINT=1
      WRITE(6,12)
   12 FORMAT(26X,'GAGE',7X,'MONTH  DAY   YEAR',4X,
     2'TIME      TIME  DISCHARGE  DEPTH   CODE'/26X,' NO.',2
     17X,'HR   MIN   INTR  TABLE NO.   (FT)'/)
C X X X X X X X X X WRITE BEGINNING DATE TIME GAGE HEIGHT IF
C       THE FIRST
C X X X X X X X X X READING OF A PAPER TAPE
      WRITE(6,46) GAGE,MT1,ND1,NY11,NY1,NH1,NM1,ARD1,NCOD
   46 FORMAT(2X,'BEGIN OF TAPE LABEL= ', 3A4,3X,I2,4X,I2,4X,
     12I2,          3X,I2,3X,I2,21X,F6.2,4X,I4/)
C  TESTING BEGINNING NUMBER OF AREC(J'S)
      IF(NSTART.EQ.0) GO TO 230
      IF(NDATE(1,1).EQ.NDATE(257,1).AND.NDATE(1,2).EQ.NDATE(
```

```
     1257,2).AND.NDATE(1,3).EQ.NDATE(257,3).AND.NDATE(1,4).E
     2Q.NDATE(257,4).AND.NDATE(1,5).EQ.NDATE(257,5)) GO TO 2
     331
      GO TO 229
 231  AREC(1)=AREC(256)
      DO 298 M=1,5
 298  NDATE(1,M)=NDATE(256,M)
      NSTART=0
      GO TO 229
 230  I=1
      K=2
      NTINT=1
      GO TO 18
 229  NTINT=NTINT+1
      I=1
      K=2
C X X X X X X X X X ROUTINE TO EDIT OUT EXTRANEOUS READINGS,
C     WRITE ON MAG
  18  IF(NSTART.EQ.1) GO TO 17
  19  IF(AREC(I).GT.GREF) AREC(I)=0.0
      IF(AREC(K).GT.GREF) AREC(K)=0.0
      IF((AREC(I).EQ.AREC(K)).AND.(NDATE(K,4).NE.24)) GO TO
     125
      IF(NSKIP.EQ.1) GO TO 4000
  24  IF(LTINT.EQ.1) GO TO 4003
 4005 IF(NLIST.EQ.0) GO TO 300
      WRITE(6,27)  GAGE,(NDATE(I,M),M=1,2),NY11,(NDATE(I,N),
     1N=3,5),NTINT,NDST,AREC(I),NCOD
  27  FORMAT(23X, 3A4,3X,I2,4X,I2,4X,2I2,3X,I2,3X,I2,4X,I3,7
     1X,I1,6X,F6.2,4X,I4)
 300  WRITE(KT) IWID,GAGE,(NDATE(I,M),M=1,2),NY11,(NDATE(I,N
     1),N=3,5),NTINT,NDST,AREC(I),NCOD
      KSEQ=KSEQ+1
      MTINT=NTINT
4000  L=I
      NUT=1
  45  I=K
      NTINT=0
  25  IF(K.EQ.J) GO TO 23
      NTINT=NTINT+1
      K=K+1
      GO TO 19
4003  WRITE(6,4004)GAGE,(NDATE(I,M),M=1,2),NY11,(NDATE(I,N),
     1N=3,5),NTINT,NDST,AREC(I),NCOD
4004  FORMAT(1X,'FIRST RECORD ON MAG.= ', 3A4,3X,I2,4X,I2,4X
     1,2I2,       3X,I2,3X,I2,4X,I3,7X,I1,6X,F6.2,4X,I4/)
      LTINT=0
      GO TO 4005
C X X X X X X X X X ROUTINE USED AFTER FIRST TIME THRU (NSTA
C     RT=1)
```

```
 17   IF(AREC(I).GT.GREF) AREC(I)=0.0
      IF(AREC(I).EQ.AREC(256).AND.NDATE(I,4).NE.24) GO TO 70
      IF(LTINT.EQ.1) GO TO 4006
4007  IF(NSKIP.EQ.1) GO TO 4001
      IF(NLIST.EQ.0) GO TO 305
      WRITE(6,27)  GAGE,(NDATE(256,M),M=1,2),NYXX,(NDATE(256
     1,N),N=3,    5),NTINT,NDST,AREC(256),NCOD
 305  WRITE(KT) IWID,GAGE,(NDATE(256,M),M=1,2),NYXX,(NDATE(2
     156,N),N=3,  5),NTINT,NDST,AREC(256),NCOD
      KSEQ=KSEQ+1
      MTINT=NTINT
 4001 NTINT=1
      L=256
      NUT=1
      GO TO 19
 4006 WRITE(6,4004)GAGE,(NDATE(256,M),M=1,2),NYXX,(NDATE(256
     1,N),N=3,    5),NTINT,NDST,AREC(256),NCOD
      LTINT=0
      GO TO 4007
 70   AREC(I)=AREC(256)
      DO 75 M=1,5
      NDATE(I,M)=NDATE(256,M)
 75   CONTINUE
      NTINT=NTINT+1
      GO TO 19
 23   NSTART=1
      IF(NCHECK.EQ.0) GO TO 55
      IF(NSTOP.EQ.1.OR.NWSH.EQ.1) NSTART=0
      IF((NSTOP.EQ.1).OR.(NWSH.EQ.1)) GO TO 95
      IF(NCOD.EQ.1000.AND.LDATA.EQ.0) GO TO 800
      IF(NCOD.GE.0010.AND.NCOD.LT.0050) NSTART=0
      IF(NCOD.GT.1000.AND.NCOD.LT.1050) NSTART=0
      IF(NCOD.GE.0100.AND.NCOD.LE.0116) NSTART=0
      IF(NCOD.GE.1100.AND.NCOD.LE.1116) NSTART=0
      IF(NCOD.GE.0118.AND.NCOD.LE.0132) NSTART=0
      IF(NCOD.GE.1118.AND.NCOD.LE.1132) NSTART=0
      IF(NCOD.GT.0133.AND.NCOD.LE.0199) NSTART=0
      IF(NCOD.GT.1133.AND.NCOD.LE.1199) NSTART=0
      IF(LDATA.NE.0) NSTART=0
      IF(NSTART.EQ.0) GO TO 95
      GO TO 800
 95   IF(NTINT.EQ.0) GO TO 21
      IF(NSKIP.EQ.1) GO TO 4002
      IF(LTINT.EQ.1) GO TO 4008
 4009 IF(NLIST.EQ.0) GO TO 42
      WRITE(6,27)  GAGE,(NDATE(I,M),M=1,2),NY11,(NDATE(I,N),
     1N=3,5),NTINT,NDST,AREC(I),NCOD
 42   WRITE(KT) IWID,GAGE,(NDATE(I,M),M=1,2),NY11,(NDATE(I,N
     1),N=3,5),NTINT,NDST,AREC(I),NCOD
      KSEQ=KSEQ+1
```

```
      MTINT=NTINT
 4002 L=I
      NUT=1
      GO TO 21
 4008 WRITE(6,4004)GAGE,(NDATE(I,M),M=1,2),NY11,(NDATE(I,N),
     1N=3,5),NTINT,NDST,AREC(I),NCOD
      LTINT=0
      GO TO 4009
  800 DO 801 M=1,5
  801 NDATE(257,M)=NDATE(J,M)
      IF(AREC(J).GT.GREF) AREC(J)=0.0
      AREC(257)=AREC(J)
   55 DO 36 M=1,5
      NDATE(256,M)=NDATE(I,M)
   36 CONTINUE
      NYXX=NY11
      AREC(256)=AREC(I)
   21 NICE=1
      RETURN
      END
      SUBROUTINE AQUFER
      LOGICAL*1 OUT2(6),ACARD(80)
      COMMON OUT2,ACARD
      COMMON/BLK1/STYPE(999),AREC(257),CREC(257),ATRA(257),C
     1TRA(257),   GAGE(3),GAG(3),NSDTE(999,3),NDATE(257,5)
      COMMON/BLK2/J,I,L,NSTOP,NCHECK,NSTORE,ISTORE,ICHECK,NI
     1CE,          NWSH,KSEQ,NSEQ,NOTE,MIAC,NSKIP,NLIST,NPFG,
     2NOPT,NCPT,NTPT,NTYPE,NX,KB,IX,MAXNO,IEOF,NOEOF,NCOD,IT
     3,KT,NSTART,LDATA,ELEREF,NSC,YACC,ACC,NTRACE,ABASE,NSNO
     4W,INDEX,NGO,NEED,NUT,ATREC,BTREC,ITIC          ,NDST,
     5NTINT,LTINT,NORM,LHEC,DREC,NTIC,ADIFF,NFIRST,NREFE,NPI
     6L
      COMMON/BLK3/NH1,NY22,NMIN,IYR,MT1,NM1,NY2,NMONTH,IHR,N
     1D1,ARD1,NH2,NDAY,IMO,IMN,NY11,MT2,NM2,NYEAR,IDA,NY1,ND
     22,ARD2,NHOUR,NYE,NYXX,  ITMO,ITDA,ITYR,ITHR,ITMN,GREF,
     3MASH,NDEX,KTMO,KTDA,KTY,KTYR,KTHR,  KTMN,NSTARE,IY,ARE
     4D,MTINT,IWID
      COMMON/BLK4/LLL(12)/BLK5/TR(2)
      LLPAS=0
      NREFE=0
      DO 21 I=1,J
      IF(AREC(I).GT.GREF) AREC(I)=0.0
      IF(ELEREF.EQ.0.0) GO TO 21
      AREC(I)=ELEREF-AREC(I)
   21 CONTINUE
      ARD3=ARD1
      IF(ARD1.GT.GREF) ARD1=0.0
      IF(ARD2.GT.GREF) ARD2=0.0
      IF(ELEREF.EQ.0.0) GO TO 20
      ARD1=ELEREF-ARD1
```

```
      NREFE=1
 20   IF(NFIRST.EQ.0) GO TO 2
      WRITE(6,17) ELEREF,ARD3
 17   FORMAT(9X,'ELEVATION REFERENCE=',F8.2,'  BEGIN GAGE HE
     1IGHT=',F6.2)
      WRITE(6,1) GAGE,MT1,ND1,NY11,NY1,NH1,NM1,NREFE,ARD1,NC
     1OD
 1    FORMAT(34X,'GAGE       MO DAY YEAR  TIME  NREFE  GAGE D
     1EPH.  CODE'//9X,'BEGIN OF TAPE LABEL= ', 3A4,2X,I2,1X,
     2I2,2X,2I2,2X,2I2,3X,I1,6X,F8.2,3X,I4//)
 2    I=0
 3    I=I+1
 4    LMO=NDATE(I,1)
      LMD=NDATE(I,2)
      LYR=NDATE(I,3)
      LHR=NDATE(I,4)
      LMN=NDATE(I,5)
      AAREC=AREC(I)
      IF(LMN.EQ.30.OR.LMN.EQ.00) GO TO 6
      IF(I.EQ.J) GO TO 15
      GO TO 3
 6    IF(I.EQ.J) GO TO 8
 5    IF(NFIRST.EQ.0) GO TO 9
      WRITE(6,7) GAGE,LMO,LMD,NY11,LYR,LHR,LMN,NREFE,AAREC,N
     1COD
 7    FORMAT(8X,'FIRST RECORD ON MAG.= ', 3A4,2X,I2,1X,I2,2X
     1,2I2,2X,2I2,3X,I1,6X,F8.2,3X,I4//)
 9    IF(NLIST.EQ.0) GO TO 11
      WRITE(6,10) GAGE,LMO,LMD,NY11,LYR,LHR,LMN,NREFE,AAREC,
     1NCOD
 10   FORMAT(30X, 3A4,2X,I2,1X,I2,2X,2I2,2X,2I2,3X,I1,6X,F8.
     12,3X,I4)
 11   IF(NSKIP.EQ.1) GO TO 13
 12   WRITE(KT)  IWID,GAGE,LMO,LMD,NY11,LYR,LHR,LMN,NREFE,AA
     1REC,NCOD,TR(1)
      NUT=1
      KSEQ=KSEQ+1
 13   NFIRST=0
      NDATE(257,1)=LMO
      NDATE(257,2)=LMD
      NDATE(257,3)=LYR
      NDATE(257,4)=LHR
      NDATE(257,5)=LMN
      AREC(257)=AAREC
      IF(LLPAS.EQ.1) GO TO 15
      GO TO 3
 8    IF(NCHECK.EQ.0) GO TO 18
      IF(NCOD.EQ.1000.AND.LDATA.EQ.0) GO TO 15
      NERROR=0
      IF(NCOD.GE.0010.AND.NCOD.LT.0050) NERROR=1
```

```
      IF(NCOD.GT.1000.AND.NCOD.LT.1050) NERROR=1
      IF(NCOD.GE.0100.AND.NCOD.LE.0116) NERROR=1
      IF(NCOD.GE.1100.AND.NCOD.LE.1116) NERROR=1
      IF(NCOD.GE.0118.AND.NCOD.LE.0132) NERROR=1
      IF(NCOD.GE.1118.AND.NCOD.LE.1132) NERROR=1
      IF(NCOD.GT.0133.AND.NCOD.LE.0199) NERROR=1
      IF(NCOD.GT.1133.AND.NCOD.LE.1199) NERROR=1
      IF(LDATA.NE.0) NERROR=1
      IF(NERROR.EQ.0) GO TO 15
   18 LLPAS=1
      GO TO 5
   15 NFIRST=0
      RETURN
      END
      SUBROUTINE OUTPUT
C X X X X X X X X X WRITE INFORMATION ABOUT THE PAPER TAPE
      LOGICAL*1 OUT2(6),ACARD(80)
      COMMON OUT2,ACARD
      COMMON/BLK1/STYPE(999),AREC(257),CREC(257),ATRA(257),C
     1TRA(257),   GAGE(3),GAG(3),NSDTE(999,3),NDATE(257,5)
      COMMON/BLK2/J,I,L,NSTOP,NCHECK,NSTORE,ISTORE,ICHECK,NI
     1CE,          NWSH,KSEQ,NSEQ,NOTE,MIAC,NSKIP,NLIST,NPFG,
     2NOPT,NCPT,NTPT,NTYPE,NX,KB,IX,MAXNO,IEOF,NOEOF,NCOD,IT
     3,KT,NSTART,LDATA,ELEREF,NSC,YACC,ACC,NTRACE,ABASE,NSNO
     4W,INDEX,NGO,NEED,NUT,ATREC,BTREC,ITIC          ,NDST,
     5NTINT,LTINT,NORM,LHEC,DREC,NTIC,ADIFF,NFIRST,NREFE,NPI
     6L
      COMMON/BLK3/NH1,NY22,NMIN,IYR,MT1,NM1,NY2,NMONTH,IHR,N
     1D1,ARD1,NH2,NDAY,IMO,IMN,NY11,MT2,NM2,NYEAR,IDA,NY1,ND
     22,ARD2,NHOUR,NYE,NYXX,  ITMO,ITDA,ITYR,ITHR,ITMN,GREF,
     3MASH,NDEX,KTMO,KTDA,KTY,KTYR,KTHR,  KTMN,NSTARE,IY,ARE
     4D,MTINT,IWID
      COMMON/BLK4/LLL(12)/BLK5/TR(2)
      NSEQ=NSEQ+KSEQ
      IF(NTYPE.EQ.1) GO TO 400
      IF(NTYPE.EQ.2) GO TO 401
      GO TO 402
  400 BREC=AREC(J)
      BRD2=ARD2*10.0
      WRITE(6,48)NOPT,GAGE,MT2,ND2,NY22,NY2,NH2,NM2,BRD2,(ND
     1ATE(J,M),M=1,2),NY22,(NDATE(J,N),N=3,5),BREC,KSEQ,MIAC
     2,NPIL
   48 FORMAT(1HO,16X,'END OF TAPE NO.',I2,',FOR GAGE-', 3A4,
     1'  END OF TAPE ON  LABEL=',I2,'/',I2,'/',2I2,' TIME=',
     2I2,I2,' READING=',F4.1/58X,'END OF TAPE COMPUTED =',I2
     3,'/',I2,'/',2I2,' TIME=',I2,I2,' READING=',F4.1//28X,'
     4THE NO. OF RECORDS WRITTEN=',I5/28X,'THE TOTAL NO. OF
     5PUNCHES FOR  PAPER TAPE WAS COMPUTED TO BE=',I5,' PUNC
     6H INTERVAL=',I2/)
      YACC=YACC+ACC
```

```
      IF(NWSH.EQ.0) GO TO 453
      WRITE(6,452)  YACC
  452 FORMAT(28X,'TOTAL PRECIPITATION FOR GAGE=',F5.1/)
  453 IF(NUT.EQ.0) GO TO 449
      GO TO 450
  401 IF(NUT.EQ.0) GO TO 449
      WRITE(6,54)GAGE,(NDATE(L,M),M=1,2),NY22,(NDATE(L,MM),M
     1M=3,5),MTINT,NDST,AREC(L),NCOD
   54 FORMAT('0',2X,'LAST RECORD ON MAG= ', 3A4,3X,I2,4X,I2,
     14X,2I2,3     X,I2,3X,I2,4X,I3,7X,I1,6X,F6.2,4X,I4//)
      NUT=0
  550 WRITE(6,50)NOPT,GAGE,MT2,ND2,NY22,NY2,NH2,NM2,ARD2,(ND
     1ATE(J,M),M=1,2),NY22,(NDATE(J,N),N=3,5),AREC(J),KSEQ,N
     2SEQ,MIAC,NPIL
   50 FORMAT(3X,'END OF TAPE NO.',I2,',FOR GAGE-', 3A4,'  EN
     1D OF TAPE ON LABEL=',I2,'/',I2,'/',2I2,' TIME=',I2,I2,
     2' READING=',F6.2/44X,'END OF TAPE COMPUTED=',I2,'/',I2
     3,'/',2I2,' TIME=',I2,I2,' READING=',F6.2/44X,'THE NO.
     4OF RECORDS WRITTEN=',I5//12X,'TOTAL RECORDS WRITTEN ON
     5 MAG. TAPE SINCE BEGINNING=',I6//28X,'THE TOTAL NO. OF
     6 PUNCHES FOR PAPER TAPE WAS COMPUTED TO BE=',I5,' PUNC
     7H INTERVAL=',I2/)
      GO TO 450
  449 WRITE(6,555)
  555 FORMAT(12X,'NO RECORDS WRITTEN ON TAPE FOR THIS PAPER
     1TAPE'/)
      IF(NTYPE.EQ.2) GO TO 550
  450 WRITE(6,49) OUT2,NCOD
   49 FORMAT(12X,'DATA FOR PAPER TAPE WRITTEN ON TAPE NO.',6
     1A1,',FOR STORAGE-- THE ERROR CODE FOR TAPE=',I4///)
      IF(NTYPE.EQ.2) GO TO 3004
      WRITE(6,3003) NSEQ
 3003 FORMAT(12X,'(',I6,')=TOTAL NO. OF RECORDS WERE WRITTEN
     1 ON MAGNET. TAPE THROUGH THIS POINT DURING FIRST EDIT'
     2//)
 3004 CALL ERMESG(NCOD)
      GO TO 3005
  402 IF(NUT.EQ.0) GO TO 815
      MON=NDATE(257,1)
      NDAE=NDATE(257,2)
      NYER=NDATE(257,3)
      NHUR=NDATE(257,4)
      NIM=NDATE(257,5)
      CTREC=AREC(257)
      WRITE(6,814) GAGE,MON,NDAE,NY22,NYER,NHUR,NIM,NREFE,CT
     1REC,NCOD
  814 FORMAT('0',8X,'LAST RECORD ON MAG.= ', 3A4,2X,I2,1X,I2
     1,2X,2I2,2X,2I2,3X,I1,6X,F8.2,3X,I4/)
  815 MO=NDATE(J,1)
      NDA=NDATE(J,2)
```

```
      NYR=NDATE(J,3)
      NHR=NDATE(J,4)
      NMN=NDATE(J,5)
      TTREC=AREC(J)
      ARD3=ARD2
      IF(ELEREF.EQ.0.0) GO TO 817
      ARD3=ELEREF-ARD2
  817 WRITE(6,816) ARD2
  816 FORMAT(37X,'ENDING GAGE HEIGHT LABEL=',F8.2/)
  813 WRITE(6,600) MT2,ND2,NY22,NY2, NH2,NM2,ARD3,MO,NDA,NY2
     12,NYR,NHR,  NMN,TTREC,NCOD,KSEQ,OUT2,NSEQ
  600 FORMAT(1H ,36X,'ENDING ON TAPE LABEL=',I2,'-',I2,'-',2
     1I2,4X,2I2,4X,F8.2/37X,'END OF TAPE COMPUTED=',I2,'-',I
     22,'-',2I2,4X,2I2,4X,F8.2/37X,'ERROR CODE FOR PAPER TAP
     3E-',I4/37X,I5,'-RECORDS WRITTEN FOR PAPER TAPE'/37X,'R
     4ECORDS WERE WRITTEN ON MAG. TAPE-',6A1/37X,'A TOTAL OF
     5 -',I5,'RECORDS WERE WRITTEN ON MAG. AT THIS POINT')
      NUT=0
      GO TO 3004
 3005 KSEQ=0
      IF(LDATA.EQ.0) GO TO 30
      DO 5000 NNN=1,LDATA
      READ(5,3001) ACARD
 3001 FORMAT(80A1)
      WRITE(6,3002) ACARD
 3002 FORMAT(28X,80A1)
 5000 CONTINUE
   30 RETURN
      END
      SUBROUTINE ERMESG(I)
C
C  SUBROUTINE  ERMESG          (REVISED BY JAN C CARR  10/71)
C  A MESSAGE IS PRINTED FOR AN ERROR CODE (NCOD) FOLLOWING T
C     HE EDIT
C  OF A PAPER TAPE, DESCRIBING THE TYPE ERROR THAT IS PRESEN
C     T FOR THE
C  DATA STORED
C
C  INVOKED BY :::  CALL ERMESG(NCOD)
C    WHERE NCOD IS A VARIABLE OR CONSTANT VALUE OF ERROR CODE
C
C  NCOD MUST BE BETWEEN THE RANGES OF (10 TO 199),(1010 TO 1
C     199),OR,
C      (1000 OR 2000)
C
C

      II=I
      IF(I.EQ.1000.OR.I.EQ.2000) GO TO 817
      IF(I.GE.10.AND.I.LE.199) GO TO 818
      IF(I.GE.1010.AND.I.LE.1199) GO TO 819
```

```
  818 PRINT 820,I
  820 FORMAT(20X,'ERROR CODE(',I4,')LAST VALUE PUNCHED ON TA
     1PE DOES NOT  AGREE WITH TRUE GAUGE VALUE')
      GO TO 811
  819 PRINT 821,I
  821 FORMAT(20X,'ERROR CODE(',I4,')LAST VALUE PUNCHED ON TA
     1PE IS TRUE GAGE VALUE')
  811 IF((I.GE.10.AND.I.LE.29).OR.(I.GE.1010.AND.I.LE.1029))
     1 GO TO 401
      IF((I.GE.30.AND.I.LE.49).OR.(I.GE.1030.AND.I.LE.1049))
     1 GO TO 501
      IF((I.GE.50.AND.I.LE.79).OR.(I.GE.1050.AND.I.LE.1079))
     1 GO TO 601
      IF((I.GE.80.AND.I.LE.89).OR.(I.GE.1080.AND.I.LE.1089))
     1 GO TO 701
      IF((I.GE.90.AND.I.LE.99).OR.(I.GE.1090.AND.I.LE.1099))
     1 GO TO 801
      IF((I.GE.100.AND.I.LE.199).OR.(I.GE.1100.AND.I.LE.1199
     1)) GO TO 901
  817 IF(I.EQ.1000) GO TO 202
      IF(I.EQ.2000) GO TO 201
      GO TO 301
  202 PRINT 1000,I
 1000 FORMAT(20X,'ERROR CODE=(',I4,') GOOD DATA TAPE-NO APPA
     1RENT ERRORS ')
      RETURN
  201 PRINT 2000,I
 2000 FORMAT(20X,'ERROR CODE=(',I4,') ESTIMATED DATA AT SOME
     1 POINT')
      RETURN
  301 PRINT 9000,I
 9000 FORMAT(20X,'ERROR CODE IS NOT VALID--CODE=',I4)
      RETURN
  401 PRINT 7000
 7000 FORMAT(20X,'TIME LOSS')
      IF(I.LT.30) II=I+1000
      ID=II-1009
      GO TO (10,11,12,13,8,8,8,8,8,8,20,21,22,23,24,25,26,8,
     18,8),ID
   10 PRINT 1010
      GO TO 812
   11 PRINT 1011
      GO TO 812
   12 PRINT 1012
      GO TO 812
   13 PRINT 1013
      GO TO 812
   20 PRINT 1020
      GO TO 812
   21 PRINT 1021
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      GO TO 812
   22 PRINT 1022
      GO TO 812
   23 PRINT 1023
      GO TO 812
   24 PRINT 1024
      GO TO 812
   25 PRINT 1025
      GO TO 812
   26 PRINT 1026
      GO TO 812
 1010 FORMAT(20X,'TIMER FAILURE GAUGE STOPPED')
 1011 FORMAT(20X,'LEAF SWITCH FAILURE GAUGE RAN CONTINUOUSLY
     1 UNTIL BATTERY FAILED')
 1012 FORMAT(20X,'TIMER FAILURE-INTERMITTANT OPERATION')
 1013 FORMAT(20X,'TIMER FAILURE-TIME DIFFERENCE AT END OF PA
     1PER TAPE')
 1020 FORMAT(20X,'NO APPARENT REASON')
 1021 FORMAT(20X,'MISTAKE IN ERROR CODE-HAS NOT BEEN ASSIGNE
     1D')
 1022 FORMAT(20X,'LEAF SWITCH FAILURE')
 1023 FORMAT(20X,'BATTERY FAILURE')
 1024 FORMAT(20X,'IMPROPER TAPE INDEXING')
 1025 FORMAT(20X,'PUNCH MOTOR OPERATES INTERMITTANTLY')
 1026 FORMAT(20X,'PUNCH MOTOR FAILURE')
  501 PRINT 6000
 6000 FORMAT(20X,'TIME GAIN')
      IF(I.LT.50)II=I+1000
      ID=II-1029
      GO TO (30,12,11,20,22,24,23,8,8,8,8,8,8,8,8,8,8,8,8,8,8)
     1,ID
   30 PRINT 1030
 1030 FORMAT(20X,'TIMER FAILURE 2-1/2 MINUTE PUNCH INTERVAL'
     1)
      GO TO 812
  601 PRINT 5000
 5000 FORMAT(20X,'INCORRECT RECORDS CODE')
      IF(I.LT.80) II=I+1000
      ID=II-1049
      GO TO (24,51,52,53,54,55,56,57,58,59,60,8,8,8,8,8,8,67
     1,68,8,70,71,72,73,8,8,8,8,78,79),ID
   51 PRINT 1051
      GO TO 812
   52 PRINT 1052
      GO TO 812
   53 PRINT 1053
      GO TO 812
   54 PRINT 1054
      GO TO 812
   55 PRINT 1055
```

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      GO TO 812
 56   PRINT 1056
      GO TO 812
 57   PRINT 1057
      GO TO 812
 58   PRINT 1058
      GO TO 812
 59   PRINT 1059
      GO TO 812
 60   PRINT 1060
      GO TO 812
 67   PRINT 1067
      GO TO 812
 68   PRINT 1068
      GO TO 812
 70   PRINT 1070
      GO TO 812
 71   PRINT 1071
      GO TO 812
 72   PRINT 1072
      GO TO 812
 73   PRINT 1073
      GO TO 812
 78   PRINT 1078
      GO TO 812
 79   PRINT 1079
      GO TO 812
1051 FORMAT(20X,'GAUGE INSENSITATIVE AT SOME POINT ON RECOR
    1D')
1052 FORMAT(20X,'SNOW WITH FUNNEL IN PLACE')
1053 FORMAT(20X,'INTAKE SILT PROBLEM')
1054 FORMAT(20X,'INTAKE PIPE STOPPED UP')
1055 FORMAT(20X,'DRIFTING SNOW')
1056 FORMAT(20X,'FOREIGN MATTER IN COLLECTOR')
1057 FORMAT(20X,'CABLE BREAKAGE')
1058 FORMAT(20X,'GAUGE TAMPERED WITH')
1059 FORMAT(20X,'FUNNEL FALLEN INTO COLLECTOR')
1060 FORMAT(20X,'PRECIPITATION LOSS NO REASON')
1067 FORMAT(20X,'PAPER TAPE SUPPLY RAN OUT')
1068 FORMAT(20X,'TIMER TURNED TO TEST POSITION')
1070 FORMAT(20X,'NOTCH OF WEIR PROBLEM(ICE)')
1071 FORMAT(20X,'LOG JAMS OR DEBRE IN NOTCH')
1072 FORMAT(20X,'VALUE GREATER THAN RANGE OF INSTRUMENT AT
    1SOME POINT')
1073 FORMAT(20X,'FLOAT TAPE DISENGAGED FROM RECORDER')
1078 FORMAT(20X,'ICE JAMMING(CAUSE HIGH G.H.)')
1079 FORMAT(20X,'HEAVY ICED CREEK')
 701 PRINT 4000
4000 FORMAT(20X,'TRACE MALFUNCTION CODE')
      IF(I.LT.90)II=I+1000
```

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      ID=II-1079
      GO TO (80,81,82,8,8,8,8,8,8,8),ID
   80 PRINT 1080
      GO TO 812
   81 PRINT 1081
      GO TO 812
   82 PRINT 1082
      GO TO 812
 1080 FORMAT(20X,'TRACE WITHOUT PRECIPITATION')
 1081 FORMAT(20X,'PRECIPITATION WITHOUT TRACE PUNCHES')
 1082 FORMAT(20X,'TRACE INCONSISTENT')
  801 PRINT 3000
 3000 FORMAT(20X,'TRANSLATOR ERRORS')
      IF(I.LT.100) II=I+1000
      ID=II-1089
      GO TO (90,91,8,8,8,8,8,8,8,8),ID
   90 PRINT 1090
      GO TO 812
   91 PRINT 1091
      GO TO 812
 1090 FORMAT(20X,'READ HEAD MALFUNCTION AT SOME POINT ON REC
     1ORD')
 1091 FORMAT(20X,'MANNUALLY INSERTED READING ON DOUBLE PUNCH
     1 WRONG')
  901 PRINT 10000
10000 FORMAT(20X,'COMPLEX ERROR CODES')
      IF(I.LT.1200) II=I+1000
      IF(II.GE.1135.AND.II.LE.1199) GO TO 8
      ID=II-1099
      GO TO (100,100,102,103,103,105,106,113,108,108,110,111
     1,111,113,113,115,115,117,118,119,120,121,122,123,124,1
     225,126,127,128,129,130, 131,131,133,134),ID
  100 PRINT 1024
  200 PRINT 1026
      GO TO 812
  102 PRINT 1080
      GO TO 200
  103 PRINT 1020
  500 PRINT 1082
      GO TO 812
  105 PRINT 1024
  600 PRINT 1023
      GO TO 812
  106 PRINT 1024
      GO TO 600
  108 PRINT 1020
  700 PRINT 1080
      GO TO 812
  110 PRINT 1023
      GO TO 200
```

```
111   PRINT 1024
800   PRINT 1081
      GO TO 812
113   PRINT 1024
      GO TO 500
115   PRINT 1012
802   PRINT 1051
      GO TO 812
117   PRINT 1070
      PRINT 1054
      GO TO 812
118   PRINT 1060
806   PRINT 1024
      GO TO 812
119   PRINT 1013
803   PRINT 1052
      PRINT 1055
      GO TO 812
120   PRINT 1023
      GO TO 803
121   PRINT 1024
804   PRINT 1052
      GO TO 812
122   PRINT 1024
      GO TO 804
123   PRINT 1024
805   PRINT 1057
      GO TO 812
124   PRINT 1024
      GO TO 805
125   PRINT 1055
      GO TO 804
126   PRINT 1052
      GO TO 200
127   PRINT 1013
      GO TO 700
128   PRINT 1023
      GO TO 700
129   PRINT 1030
      GO TO 200
130   PRINT 1081
      GO TO 806
131   PRINT 1024
807   PRINT 1091
      GO TO 812
133   PRINT 1072
      PRINT 1073
      GO TO 812
134   PRINT 1020
      GO TO 800
```

```
    8     PRINT 80001
80001 FORMAT(20X,'ERROR CODE HAS NOT BEEN ASSIGNED')
  812 RETURN
      END
      BLOCK DATA
      COMMON/BLK4/LLL(12)/BLK5/TR(2)
      DATA LLL/31,28,31,30,31,30,31,31,30,31,30,31/,TR/1H ,1
     1HT/
      END
```